

UNITED PLANTERS' ASSOCIATION OF
SOUTHERN INDIA

TEA SCIENTIFIC
DEPARTMENT

ANNUAL
ADMINISTRATION REPORT

FOR

1938-39



MADRAS

PRINTED AT THE DIOCESAN PRESS, VEPERY

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SCIENTIFIC STAFF

<i>Tea Scientific Officer</i>	...	J. D. Manning, B.Sc. (Agr.).
<i>Entomologist</i>	...	S. Ananda Rau, M.Sc.
<i>Mycologist</i>	...	M. K. Subba Rao, B.Sc.
<i>Soil Chemist</i>	...	V. Jayaraman, B.A., B.Sc. (Agr.).

U. P. A. S. I.

TEA SCIENTIFIC DEPARTMENT

ANNUAL REPORT 1938-39

Staff.—The Tea Scientific Officer arrived at the Experimental Station on May 4, 1938, and took up duties immediately.

The provisional notice, as reported in the Annual Report for 1937-38, given to Mr. V. Jayaraman, the Soil Chemist, was withdrawn.

Advisory Work.—Letters received during the year numbered 945 and the number despatched 991. The Mycologist has been in South Travancore since May 1938 investigating a serious and widespread 'die-back' disease of Tea. He has continued advisory work on all Mycological problems.

Touring.—A considerable amount of touring was done by the Tea Scientific Officer during the year. During August and September a tour lasting over three weeks included visits to member estates in South Travancore, Central Travancore and Mundakayam. During October a tour lasting a fortnight was made in the Anamallais, and this was followed by a tour in the High Range. A second visit to the High Range took place in March this year when the second part of the programme originally arranged for October was completed.

In December an official tour was made of estates in the Nilgiris.

Most estates on the Nilgiri-Wynaad were visited from time to time.

A short visit was paid to Mr. Mayne the Coffee Scientific Officer in February; one tea estate in Mysore was visited at the same time.

It had been hoped that it would be possible for the Tea Scientific Officer to tour all the Tea districts during the year, but unfortunately this was not possible. It is intended to tour the remaining districts early in the coming year. Altogether 92 visits to estates have been made.

The Entomologist carried out a three weeks' tour in Travancore. This tour was mainly connected with the problem of *Helopeltis*.

The Mycologist, as stated above, has been in South Travancore, almost throughout the year. Short visits were paid by him to Peermade and Vandiperiyar.

Publications.—No fresh publications appeared during the year. Two articles, one by the Tea Scientific Officer and one by the Entomologist, appeared in the *Planters' Chronicle*.

Research Work.—With the considerable amount of touring undertaken during the year it has not been possible to do much in the way of research work, and the main work in this connection has been done on the 'Die-back' disease of Tea in South Travancore. Investigations on this subject are being supplemented by field trials. It is hoped that a bulletin on the 'Die-back' disease will be published late in 1939.

Co-operation of Scientific Work.—Discussions on the possibility of co-operation of scientific work on plantation crops have taken place at various times during the year. Many problems are similar in all crops such as Tea, Coffee, Rubber, etc., and it is felt that a good deal of overlapping could be avoided. At the request of the Tea Product Committee the U.P.A.S.I. Coffee and Tea Scientific Officers met at Balehonnur and discussed means of co-operation in scientific work. For various reasons it was found impossible to unite the two departments in any way, but the Officers came to the conclusion that they had many common problems on which there could be a valuable exchange of information, and that in this way wide co-operation was possible, and duplication of certain work could be avoided.

Field Trials.—It was decided early on that the Tea area at the Experimental Station should be retained by the Station. With this small acreage it is quite impossible to carry out extensive field trials, and except in a small way, no attempt has been made to do so. The tea area has however been invaluable in testing out proprietary mixtures of various kinds, and it is of great advantage to have a small area of tea for minor experimental work.

It is quite clear that there is an enormous amount of field trial work which requires to be done in South India. Furthermore, owing to extreme variations in conditions of soil and climate, in many cases, it is not possible to obtain results for the whole of South India by a trial in one particular district. Trials replicated over a variety of conditions are called for, and should give the most reliable results. It will be clear, then, that the Department is bound to seek the co-operation of Planters in carrying out trials. The response of Planters in this direction has been most encouraging, and with this ready response there is wide scope for important experimental work.

It is not uncommon that Planters wish to carry out their own particular experiments. The staff of the Scientific Department will at all times be pleased to give advice on the lay out and general conduct of any such 'private' experiments.

Pests and Diseases.—These are fully dealt with in the reports of the Entomologist and Mycologist. The report of the Mycologist is necessarily

of a somewhat technical nature, and in order that the situation may be followed without referring to technical terms a summary of the report is also published.

Composts.—A large number of compost samples have been analysed during the year. The results of the analyses clearly show that the technique of making good composts is well understood. The Indore method of making compost is by far the most widely used in South India, and is the method generally recommended. Compost making is, however, an elastic process, and where either the necessary materials or necessary conditions are not available variations in the method of manufacture are called for. Where, for one reason or another variations in the method of manufacture are tried out, it is advisable that analysis of samples be undertaken as such analyses may show some fault in the method employed. Further notes on compost are included in the report of the Soil Chemist.

Soils.—As will be seen from the report of the Soil Chemist a considerable number of soil analyses have been done in the laboratory. It has not been possible during the year to proceed with the proposed survey of South Indian Tea soils, owing to the amount of analytical work, but it is hoped that at least a start may be made in this direction during the coming year. When soil samples are received for analysis it is of great advantage if the results of the analysis can be compared with the average soil of the district concerned. It is many years since figures for the district averages were obtained, and it is felt that a re-survey is indicated.

Exhibition of Specimens at U.P.A.S.I. Annual General Meeting.—A large number of interesting specimens are received at the Station. It is felt that an exhibition of these and collected specimens of composts, soil, pests and diseases of tea and shade trees and green manures, and any other specimens of interest, would be of interest to Planters. The approval of the Tea Product Committee has been obtained to hold such an exhibition in Coonoor at the time of the Annual General Meeting.

Buildings.—Electric light and water supply have been extended to the Soil Chemist's bungalow.

Electric Light and Power Supply.—Pykara power was installed at the Station during the year. This has resulted in considerable saving and greater efficiency.

Rubber.—A number of enquiries have been received in connection with Rubber, and whenever possible these have been dealt with. A scheme has been evolved whereby Rubber problems could receive greater attention, and it is understood that the proposals are to be put before the interests concerned for their consideration.

Meteorological.—Total rainfall for the year was very much below average, and an abnormal drought has been experienced. There was an almost complete failure of the North-East Monsoon, and two-thirds of the total rainfall occurred during June, July and August. The rains usually anticipated during the end of December were absent, and January, February and March were practically rainless.

METEOROLOGICAL

(1938-39)

Month.	Rainfall in inches.	No. of days with rain.	Temperature.		Humidity.		Vapour Pressure.		Cloud.	
			Average Afternoon Maximum.	Average Overnight Minimum.						
			8-30 A.M.	3 P.M.	8-30 A.M.	3 P.M.	8-30 A.M.	3 P.M.		
April '38...	4.09	9	84.2	64.4	89.4	70	22.5	24.9	2.4	2.7
May „ ...	2.91	9	82.0	65.9	86.1	74.2	22.8	24.4	2.5	3.4
June „ ...	16.13	30	73.1	64.1	93.8	94.2	21.3	23.0	7.6	9.0
July „ ...	12.42	28	72.7	63.6	95.1	86.1	20.9	22.1	7.0	6.9
Aug. „ ...	12.18	27	75.2	63.5	94.7	86.9	22.1	23.3	5.6	7.1
Sept. „ ...	5.82	22	75.7	62.8	94.0	87.2	21.6	23.2	4.5	7.2
Oct. „ ...	4.44	12	76.6	61.3	89.0	76.9	20.5	22.0	2.6	3.7
Nov. „ ...	1.43	6	77.4	59.5	85.6	65.8	18.9	19.3	1.6	2.2
Dec. „ ...	0.94	4	78.4	58.8	86.7	54.1	18.1	16.6	1.9	1.8
Jan. '39...	0.06	1	79.2	57.7	86.7	44.6	16.6	14.6	0.8	1.2
Feb. „ ...	—	—	83.8	57.9	82.4	39.9	17.3	14.7	—	0.5
Mar. „ ...	0.57	3	85.8	60.7	78.1	42.0	19.0	16.0	—	1.1
Total ...	60.99	151								

Acknowledgement.—It is a great pleasure to record appreciation of the members of the Tea Scientific Sub-Committee.

Also of the help given by Agents and Managers in the conduct of experimental work.

The Department has continued to benefit by the loan of books from the library of the Agricultural College at Coimbatore. Thanks are due to the Principal and staff for this help and also for their valuable assistance in the identification of botanical specimens.

Thanks are also due to the Forest Department at Dehra Dun for identifications, and information in regard to entomological specimens.

The Imperial Bureau of Mycology, and the Imperial Institute of Entomology have given valuable assistance..

Very grateful thanks are extended to the numerous Planters throughout South India who have extended hospitality to members of the staff, while on tour.

PLOT DETAILS

OLD TEA

Month	Green Leaf		Made Tea per Acre	
	During Month.	Total	During Month	Total
April	385	...	32	...
May	470	855	39	71
June	448	1303	41	112
July	627	1930	52	164
August	484	2414	40	204
September	584	2998	48	252
October	352	3350	29	281
November	340	3690	28	309
December	456	4146	30	339
January	148	4294	12	351
February	35	4329	3	354
March	...	...	...	...
Average yield over 13 years				328

1926 PLOT

Plots Nos.	Nil	Compost at the rate of 5 tons/acre	Fresh Green Manure at the rate of 10 tons/acre	Artificial at the rate of 350 lbs./acre (2 : 1 : 1)
	lbs.	lbs.	lbs.	lbs.
1	...	...	159	...
2	...	...	...	135
3	134	...	...	...
4	...	208	...	...
5	...	86	...	...
6	86	...	...	...
7	...	...	...	113
8	...	...	125	...
9	...	...	...	104
10	...	...	74	...
11	...	85	...	...
12	56	...	...	...
13	68	...	...	...
14	...	91	...	...
15	...	...	109	...
16	...	...	...	97
Total ...	344	470	467	449

1927 PLOTS

Sub-Plot Nos.	Clean weeding and no other cultivation	Clean weeding with Annual deep cultivation	Sickle weeding during monsoon with Annual deep cultivation	With Annual deep cultivation	Nil
	lbs.	lbs.	lbs.	lbs.	lbs.
3 A	58	...	...	...	...
3 B	...	...	...	...	54
4 A	...	...	...	76	...
4 B	...	41	...	...	...
5 A	...	...	...	...	112
5 B	...	...	...	39	...
6 A	...	...	...	132	...
6 B	...	...	...	...	55
7 A	115	...	...	...	...
7 B	...	78	...	...	...
8 A	...	...	121	...	...
8 B	...	...	...	88	...
9 A	...	107	...	...	...
9 B	71	...	...	...	...
10 A	...	...	...	...	109
10 B	...	...	95	...	...
11 A	105	...	...	...	...
11 B	...	85	...	...	...
12 A	...	...	...	...	96
12 B	...	...	...	92	...
13 A	...	...	...	98	...
13 B	...	...	84	...	...
14 A	...	94	...	...	...
14 B	...	...	...	...	87
15 A	...	...	111	...	...
15 B	101	...	...	...	...
Total ...	450	405	411	525	513

1928 PLOTS

—		15 Betjan	16 Dangri	17 Dhonjan	18 Nellimunda
Section 1	...	167	314	274	259
” 2	...	176	154	212	223
” 3	...	163	150	207	221
” 4	...	202	274	196	168
” 5	...	247	369	278	292
Average ...		191	250	233	233

PLOTS 19-22

Year	Average Yields		
	19 and 21 High Pruned	20 and 22 Low Pruned	15 to 18 Low Pruned
1930-31	56	...	...
1931-32	183	88	66
1932-33	636	344	395
1933-34	770	706	755
1934-35	402	279	450
1935-36	965	943	1078
1936-37	1449	1396	1310
1937-38	514	521	478
1938-39	530	504	202

1928 CONTOUR

Sub-Plot	23	...	160 lbs. made tea per acre.					
"	24	...	128	"	"	"	"	"
"	25	...	160	"	"	"	"	"
"	26	...	136	"	"	"	"	"

1929 PLOTS

Sub-Plot	27	...	920 lbs. made tea per acre.					
"	28	...	690	"	"	"	"	"
"	29	...	550	"	"	"	"	"
"	30	...	450	"	"	"	"	"
"	31	...	520	"	"	"	"	"

1930 PLOTS

Sub-Plot	33	...	652 lbs. made tea per acre.					
"	34	...	990	"	"	"	"	"
"	35	...	690	"	"	"	"	"
"	36	...	575	"	"	"	"	"

AGRICULTURAL

Tours throughout almost all the South Indian Tea districts have given me the opportunity of discussing with Planters, on the spot, the problems which face the industry, especially from the agricultural point of view. The object of this note is to set down the impressions gained by these tours, and in some measure to discuss the major agricultural problems. On many of these problems there is little or no evidence on which definite opinions can be given at present, but it is hoped that with the development of field trials on estates a better understanding will be obtained on at least some of the outstanding questions. As this note in some measure constitutes a report on the tours undertaken, it is included in the Annual Report of the Station. The subjects are discussed under a number of headings, although all these subjects are necessarily closely connected with each other.

General.—It may be said at the outset that owing to the extreme variations in the soil and climate, and owing to differences in elevation, the culture of Tea differs greatly in the various South Indian Tea districts. This is only to be expected, and naturally conforms with the laws of agriculture which seldom permit standardisation to a wide extent. Each soil, and sometimes even each field, requires treatment on its own merits. That different methods are adopted in different districts, and often on different estates in the same district, is, surely, a healthy sign since it shows the realisation that agriculture in any form requires consideration of local conditions. While it is, of course, true that there are general principles which form the basis of any system of cultivation or treatment, yet when one gets variations in climate, and soil and situation, variations in practice are called for.

It is, for instance, important to recognise the difference in the soils of say, for example, the Nilgiri-Wynaad and the High Range. The method of tillage of soils with such wide differences cannot, surely, be the same. Nor can we expect that a similar manuring programme would give similar results where the soil to be manured is chemically and physically a different medium acting under a different climate. One might go further and assume that the soil, climatic conditions, etc., over a particular area are the same, but find that in one case there is a complete cover of tea and the soil fully occupied by roots; while in another case a similar soil has a large number of vacancies; or one field might be thickly shaded and another without shade. In spite of the common factors in each case, there is every reason to believe that the methods of tillage in the two cases should be different. Can one, for example, expect the results of forking to be the same in a field with a complete cover of Tea and another with a sparse cover? Or the response to manuring to be the same with or without shade? The evidence of experimental work suggests that one cannot, and that the best treatment whether it be tillage or manuring is largely a matter to be decided on the merits of the particular case.

The temptation to follow what has been considered for many years as being good practice is a natural one, and at any rate a fairly safe one, but in agriculture as a whole it is now being generally realised that some of the methods which have been standard practice for generations are not always as sound as they have for so long seemed. In British farming practice, for example, it has always been considered that for most crops

the freer they are kept from weeds and the more soil cultivation that is done the better. The tendency now, is to realise that while the crops must be kept clean to a certain extent and that there must be a degree of cultivation, yet, there comes a point after which further cultivation actually depresses the crop. During the development of common practices labour was more plentiful and cheaper than it is to-day, but with the growing cost of labour and in most European countries the growing shortage of labour the need for economy has led to modified and, very often, sounder methods. If there is one lesson to be learnt from this modern tendency it is the need for careful examination of all field practices to make sure that the particular practice is necessary, economical and sound; moreover, that it is the best method for a particular district or estate or even a particular field. The question of forking in tea forms a good example of what is meant. Nearly all Tea in South India is forked periodically, and it has been considered sound practice that it should be so. It is, however, a subject which requires further investigation. In some soils and under certain conditions it is probably necessary, but under other conditions it is conceivable that it will eventually be shown that forking should not be in the programme at all. A particular method or practice can only be regarded as sound and as the best until we know more about it. Very often it is a change in the conditions of labour, of cost of production or the need for economy that leads to a modification of present methods, and the discovery of better methods of field practice.

If agricultural practices which have appeared sound for centuries on end, are now found, as is common in British farming, capable of improvement, it can only be suspected that there is correspondingly more room for improvement in the tillage of those crops which have only occupied our attention in comparatively recent times. This is especially so as the experience gained over hundreds of years in temperate lands cannot be made use of in tropical soils without important modifications; particularly in the case of actual tillage operations and the whole question of the manuring of tea.

Manuring.—Attempts have been made during the year, and especially in the course of tours, to get an understanding of the present position of manuring tea in South India. It is a subject of the greatest importance, and when the economics of the situation are considered, one cannot help feeling that it is unfortunate that confusion exists to the extent it does and that the amount of evidence on the subject applicable to all South Indian conditions is so scanty. A great deal of very valuable work on the manuring of tea has been, and is being done, both in North India and Ceylon. We are extremely fortunate in having this evidence but it does seem more than probable that certain modifications are required for conditions in South India in view of differences in climate and soil and general treatment. On a subject involving the expenditure of lakhs of rupees it is essential for the well being of the industry that there should be no middle course.

While one can, with most crops, rely to some extent on experiences and experimental work in connection with similar crops, tea presents special difficulties since there are many reasons why the manuring of it differs from the manuring of most other crops. By far the greatest amount of experimental work on manuring has been done on annual crops on which direct evidence has been more easily obtained.

It might be of interest to examine some of the reasons why the manuring of tea may be expected to differ from the manuring of 'general' crops. To begin with, the foliage has a high percentage of Nitrogen and it seems unquestioned that tea is an exceptionally heavy Nitrogen feeder; unlike the majority of crops it prefers an acid soil and this calls for far reaching modifications in manuring; it is a very long lived perennial and exhaustion of the soils cannot be redeemed by fallowing; it is pruned periodically and, in South India at least, except for a short period following pruning gives up its crop throughout the year; vitality has to be maintained over a long period of years; the crop is the leaf and not fruit, and manuring should not have a tendency to bring the plant to seed; in most cases it grows along with other plant life, i.e. shade trees, cover crops; the loppings and leaf fall of shade trees, the tea prunings and incorporation in the soil of weeds, mean the return to the soil of a considerable amount of organic matter; it is very deep rooted and requires a supply of moisture and nutrients in a deep soil profile. From a consideration of these points it will readily be understood that the manuring of tea is a specific problem, and not too much reliance can be placed on results obtained with other crops.

In considering manuring for any crop there is one important factor that must receive first attention—this factor is the soil; and before manuring of any kind can produce results it is obvious that the soil must be in a condition such that not only by its constitution is it a suitable medium for plant growth, but also by its condition is it capable of giving up its nutrients to the roots of the plant. Perhaps more than manuring or plant nutrition, this is a question of soil nutrition. A single example will suffice to explain what is meant. Two soils are considered similar in all respects except that one is thoroughly drained and the other not. Growth in the first is luxuriant and in the second poor. The first responds to manures, the second does not. This is common experience, and shows the importance of the soil medium, and that before any money is spent on manures care should be taken to be sure that the condition of the soils is such that there can be a response to manuring whether it be cattle manure, compost or artificials. In the case of the first two, cattle manure and compost, it is in many instances probable that the benefits derived from application are due to the improvement in the physical condition of the soil as much as to the extra plant nutrients added. With artificial fertilisers the effect is more usually due to the plant nutrients, though if those produce an increase of plant growth which is incorporated in the soil as organic matter, the effect in this case may well be indirect as well i.e. the effect is partly through an improvement in soil condition, not caused by the fertiliser itself, but as a result of the fertiliser having led to increased plant growth. However, this increased plant growth could not have taken place even with abundant fertiliser, had the soil not been in at least a fair condition to support growth. The main point is that the best results from manuring can only be obtained when the soil is in a condition to respond—if it is badly drained or in bad tilth the response to manuring in increased plant growth cannot be expected. Moreover it is matter of economy—half the amount of artificial fertiliser will produce a better response in a soil in good condition than will double the amount in a soil out of condition.

The indirect effect of manures undoubtedly has a very big part to play in South Indian conditions, and this especially in the heavier types

of soil and in the more exposed soils, and generally in those areas where the return of organic matter to the soil is least, and where losses take place most rapidly. The word 'manures' is used to include the whole range of organics and inorganics, assuming that increased growth of all plants in a tea area results from the use of inorganics and that the great part of this increased growth is incorporated in the soil, thereby increasing the organic matter content.

It is possible too, that the indirect effect of the natural organic manures (cattle manure, green manure and compost) has an important part to play in the soils of the tea areas in the higher elevations. Most of the high elevation soils, in a chemical analysis, are shown to contain abundant plant foods, with very often an exceptionally high percentage of Nitrogen. .5% Nitrogen is a not uncommon figure. It appears however that the bulk of this nitrogen is not available to the plant, and what is required more than anything else is a treatment which will make available increasing quantities of this vast bulk of natural soil Nitrogen. Observations would show that decomposition of organic matter is slow in these districts; this is partially attributed to the lower temperatures which accompany higher elevations but there is reason to suspect at the same time a low microfloral population in the soil. The use of cattle manure and composts, more than anything else, is regarded as the hopeful way of enlivening the soil, and where manures of this kind have been used the results have been encouraging. Owing to rapid changes it is not possible to determine the amount of nitrogen in the nitrate form in the case of samples which take some time in reaching the laboratory, and consequently little use can be made of chemical analysis to determine the amount of nitrate nitrogen in the soil. As has been said, however, preliminary observations on the use of cattle manure and composts at high elevations have given encouraging results. Soil bacteria and fungi, it is agreed, play a very considerable part in making available plant foods in the soil. For South Indian conditions at least our knowledge of the activity of the microflora is very limited, and the relationship between the soil microflora and the availability of plant nutrients is a field of investigation in which it is felt that important work remains to be done. We must endeavour to get the soils to 'live'.

The composting of waste materials is a process well understood in South India, and large quantities of compost are made annually. The Indore system is the one in general use, though the Lincoln system is widely used during the monsoon. The use of compost as a manure for tea has been the subject of considerable discussion, and much has been written about it. It is not proposed in this note to carry the arguments for and against composting further. One of the great merits of the 'compost controversy' has been to stimulate the realisation of the importance of organic matter to the soil. And, perhaps, to show that there is within estates a great deal of waste material of which valuable use might be made. Under our conditions of climate losses of organic matter from the soil are intensified as compared with temperate climates, and it is believed that the importance of keeping up a high percentage of humus in the soil, and replenishing the losses, is fully realised. There can be little doubt that a good deal of soil deterioration which has taken place in the past has been due to the fact that insufficient care was taken to maintain a supply of organic matter to the soil. It is unfortunate that in the general controversy there has been

the tendency to discuss manuring on an organics *versus* inorganics basis. A plea is made that instead of pitting one against the other, the subject may be viewed from a different angle, namely how far is it possible, economic and sound agriculture to supplement the one with the other. No one will dispute the value of organic matter to the soil; it may not be, and probably very often is not, necessary that the organic matter be in the form of compost. Compost is, however, a very suitable form of waste material to add to the soil, and with the value of cattle manure fully realised, it has the great merit of making the cattle manure go a great deal further; and being partially decomposed it is an excellent form in which to add the 'tougher' type of plant material to the soil. At the same time the value of the proper use of artificial manures is well established. There are many cases where artificial manuring has been overdone and the accumulative effect has been bad, but the danger of this is almost entirely absent provided the soil is well supplied with humus, and provided that the treatment of the crop remains normal, and that abnormal measures, of say in the case of tea, plucking, are not resorted to as a result of stimulation by artificial manures. If we take the addition to the soil of organic matter as the basis for manuring and supplement this, where bigger yields are required or where yields show signs of falling, with a well planned programme of artificial manuring, there is every reason to believe that the manuring of tea is on a sound basis.

The amount of compost that can be made on a particular estate is dependent on the availability of waste products. Some estates are very much better placed than others, and there are extreme cases of abundant grazing land for cattle and acres of jungle, while another estate may be very limited in both these facilities. Much is, however, being done in the case of estates not so well supplied with material for composting, to improve the situation. Larger quantities of cattle manure are being made available by using an acre or two of land for growing grasses or other suitable crops to supplement the food the cattle obtain by grazing. In many instances swamps have been drained and planted with grasses such as napier or guinea grass which provides a large amount of feeding for cattle, and consequently allows the maintenance of a larger herd. Also greater facilities are being made for the feeding and control of cattle owned by the estate staff. And here it might be mentioned that in at least two districts very valuable work has been done in improving the quality and general health of the cattle.

For the increased supply of green material there is a widespread movement to make fuller use of waste land by planting up such land with crops suitable for either composting or incorporating in the soil direct. For this purpose leguminous crops are generally used, but other crops are also suitable. Sunflower and Mugwort, for example, afford an abundant supply of very valuable material. In other ways too, efforts are being made to obtain greater supplies of material to incorporate in the tea areas and this has resulted in better housing and control of estate cattle, and in the storage of feed for cattle for the time when pasture feeding is scarce.

Shade.—Shade in Tea is a subject which appears to be receiving considerable attention and is closely occupying the minds of Planters. Shade has to be considered from almost as many aspects as the main crop itself, and there is the added difficulty that it is almost impossible to assess its

value. The actual influence of shade on the growth and quality of Tea may at first sight seem to be the most important aspect of this problem, but in tropical soils which without shade are exposed to the effects of sun and heavy rain, there can be little doubt that it is the indirect influence which is of the greatest importance—that is, the protection from sun and the beating effect of rain which shade trees give the soil. Very few tropical soils are particularly rich, and the soils of the South Indian Tea districts, taken as a whole, are probably not much above the average. They are certainly liable to deteriorate unless carefully managed and in the case of a perennial crop such as tea which occupies the same soil for perhaps fifty to eighty years, the importance of maintaining the soils in a state in which they are capable of holding a crop which will produce an economic yield from healthy plants must be fully realised. Even if our soils received the minimum of protection there is little doubt that they would go on producing crops for many years, and for a further period yields might be maintained by adequate manuring, but the aim should surely be the maintenance of the condition of the soil so that crops can be produced at an economic rate and without having to resort to gradually increasing artificial replenishment of the soil. There is no scope for the nomadic habit. There is evidence to suggest that the action of sun on exposed soils is the most important factor in soil deterioration, assuming there is no actual loss of soil by erosion. A realisation of this shows the importance of shade in tea, and leads to the belief that it is only by a carefully planned system of shading that the value of the soil can be maintained, for the future. Sound agriculture in tea culture demands the protection of the soil and its maintenance at a high level of fertility. It is fully believed that this aspect of shade is of vital importance and should receive first consideration and that the other benefits to be derived from shade are of less concern. The value of the mulch from the leaf fall and loppings of shade trees; the actual shading of the bushes; the wind protection and effects of the roots in opening up the soil, all these undoubtedly merit close attention, but are secondary to soil protection.

The question which then arises is how thickly the shade should be planted and what types of trees should be used. These are questions over which there would appear to be a good deal of difference of opinion, and, as many local factors have to be taken into account, a general answer is not possible. Perhaps the best one can say in regard to thickness of shade is that the spacing of the trees should depend on the amount of protection each tree, by its vigour and habit of growth, gives to the soil. And that where the tea itself, through immaturity or other causes, does not provide a cover, the shade should be thicker than where the main crop affords a fair measure of soil protection. That, at least, is the deduction that can be made if we regard the main function of shade trees to be the prevention of soil deterioration caused by the climate. The main crop on its own account provides a good protection to the soil where the cover is complete or almost so and in such cases there is less purpose in shading to prevent soil deterioration and only a lighter shade forming some protection for the crop is required.

And what species of tree to use? This would appear to be one of the major problems in South India, and the number of species at present being used for shade cannot be regarded as satisfactory. New species to suit all elevations are needed as it is felt that the only method of

tackling the problem of diseases in shade trees depends on our having a great variety of suitable trees. Some estates have made a practice of mixing the shade, that is, employing a number of different trees, and in view of the danger of the appearance and spread of disease in shade trees it is a practice which has everything to recommend it. In other cases it is felt that too much reliance is placed in a single variety. The mixing of shade has assumed importance with the recent rapid spread of the leaf disease *Phyllosticta* which attacks grevilleas. If only one or two varieties are used and disease appears, the chances of spread of the disease are considerably greater than if a number of different trees are used. Where we have a number of species, each one acts as a protection for the other since diseases are usually specific and attack only one species. Thus the *Phyllosticta* disease attacks grevilleas but not *albizzias*.

One of the principles of that sound agricultural principle, the rotation of crops, is that the crops shall be separated in space. It is possible to conform to this principle in shade trees if a number of different species are employed so that each tree is separated by other trees from the next one of the same kind. Spraying against diseases of shade trees will always be a doubtful economic proposition and the greatest hope in ensuring freedom of pests and diseases is to mix the shade. For the lower and middle elevations in South India there are a number of useful shade trees such as grevilleas, *albizzias*, *dadaps*; a mixture of these and others should ensure a certain degree of protection. For the higher elevations the number of available trees is more limited. Throughout we do require a greater number of useful trees. Attacks by *sambhur*, exposure to strong winds, in some cases preclude the use of some kinds of trees, and such factors make the position more difficult. A careful search for new trees is always being made—there can be little doubt that there are numerous trees which would be suitable for growing in tea in our South Indian climate,—but meanwhile one cannot help feeling that in planning shading, attempts should be made to make use of all the varieties we have in use at present, so that the shade may be well mixed. The comparative absence of disease amongst shade trees in Coffee in Mysore where the shade is usually a mixture of a great number of trees, is perhaps the strongest argument that can be put forward in advocating a mixture, and not reliance on one or two species.

There does appear to exist a prejudice against some of the trees common in South India, it being believed that they are responsible for the spread of root disease. There is, fortunately, no evidence to the effect that any one particular kind of tree is liable to lead to root diseases. *Albizzia moluccana*, for example is in some quarters regarded as being a source of root disease. There is, fortunately, evidence that this particular tree is not a bad culprit, and that it can be grown without abnormal danger to the tea. Perhaps the greatest defect of *A. moluccana* is its tendency to brittleness.

The influence of shade trees in wind protection is an important point and is referred to in the section on wind.

Wind Breaks for Tea.—The protection of tea from wind is a problem which is of great concern on many estates, and is undoubtedly one of importance owing to the depressing effect which strong winds have on growth. Perhaps, on the whole, this aspect receives less attention than it should,

From the general position it seems that almost all tea is subject to heavy winds at one time or another during the year, and that these winds, especially the strong land winds have an adverse effect. It may, in fact, be the limiting factor in growth and development.

Under jungle conditions the growing trees protect each other from wind and this affords the necessary protection for growth. If these trees were planted in exposed situations very few of them could reach maturity, and where winds are strongest it is common to find high jungle only in the better protected situations such as the valleys. Moreover, when jungle is felled and belts of jungle are left as wind belts we know it is necessary that they be sufficiently wide, otherwise the effect of wind will gradually destroy the belt. The variety of growth under jungle conditions affords protection to individual plants from disease and wind. In its natural habitat, tea is a tree and may be described as a jungle plant. Protection from wind then would appear to be an important factor in its development. Once established, tea bushes afford a certain amount of wind protection to each other, but it is very seldom adequate for maximum growth. Shade trees do give a certain amount of protection from wind, and in many cases they are so planted as to act chiefly as wind belts, with other trees at longer intervals between the belts. This would seem to be sufficient protection in most cases, but where winds are stronger, something more may be necessary, and one effective method of tackling the problem would seem to be the use of hedges at close intervals in the tea. Two or three rows of tea bushes allowed to grow up to say 10-15 feet make a useful belt, but other plants may be just as effective. Hedges of *Melanoxylon* or *Acacia* closely planted, for example, afford efficient breaks. At lower elevations some of the green manure plants should be satisfactory as wind breaks if allowed to grow up. In very exposed situations this plan could be extended by dividing the tea area into small squares each square enclosed by a suitable hedge, supplemented throughout the area by wind belts of high trees. Until the tea is well established some method of this kind might be recommended, and it may well be found worth keeping up even after the tea has become well established.

Soil Cultivation.—The cultivation of the soil in tea areas shows wide differences throughout South India, and is generally dependent on local conditions of soil and climate. On one hand one finds tea soils which are forked at least once a year; on the other hand a large area is never forked at all or only at very long intervals. Between these extremes come a number of modifications. The 'Envelope' method of forking is by far the most universally adopted system, but 'turn over' forking is the usual practice in the heavier types of soil.

To what extent forking is necessary and sound practice is a problem which is receiving a considerable amount of attention in South India. If we turn once more to the jungle and study the condition of the soil we find that it approaches in texture an ideal condition. How do we account for this? In the first place the soil is protected by different layers of jungle growth—the trees, the shrubs and the ground cover plants—from the sun and the direct beating effect of rain. Secondly the soil is fully occupied by plant roots which keep it 'open' and in a good physical condition. Thirdly there is a continual leaf fall, and return to the soil of large quantities of organic matter. Fourthly the soil is almost entirely

free from trampling. With these conditions vigorous plant growth takes place year after year without any disturbance of the soil. Yet the soil remains in a condition which will not only support plant growth but even small seeds are able to germinate, get a root hold, and grow. The fertility of the soil remains about constant.

If we now consider the case of an area under tea we find a number of important modifications. With the smaller number of trees there is less protection of the soil from sun and rain. There is less variety of growth in tea; admittedly there are shade trees (high growth), tea (medium growth) and weeds and cover crops (low growth) but the exploration of the soil by the root systems of the growing plants is not so complete as it is in jungle. There are certainly less trees of widespread and deep-rooting systems to 'open' up the soil, especially in the deeper layers. The whole soil profile—top soil and sub soil—is less fully occupied. The leaf fall and return to the soil of organic matter is reduced in tea areas, and finally with periodical rounds of plucking the soil is subjected to considerable trampling. The effect of this trampling is very much greater in the heavier clay soils than it is in the more open loam or sandy soils.

Having compared the conditions which exist in jungle and in tea it now remains to see how far the modifications from jungle which prevail in tea require correcting; in fact, how much cultivation of the soil is required for tea. The wide differences in soil type mean that there can be no one answer for all soils, and that each must be considered on its own merits. What does seem obvious is that where there is at least a fair degree of shade, a complete cover of tea, and where clean weeding is not practised, there is a near approach to jungle conditions, and surely under these conditions a minimum of soil disturbance is called for, since the soil is protected, is relatively fully occupied by roots and there is a large return to the soil of organic matter in the shape of leaf fall, prunings, and decaying plant material. The contention that the minimum of soil disturbance is required under these conditions is supplemented by the realisation that disturbance of the soil means also disturbance of the root system; and the idea that the more one cultivates the better, has now been shown to require considerable modification.

If forking is considered for tea growing under this approximation to jungle conditions it would seem that one must make certain that the effect of the soil disturbance is not such as unduly to harm the root system of the crop, and is done only at a time when the soil is receptive to cultivation; that is, at a time when forking will improve its physical condition. Forking, for instance, when the soil is too wet may lead to 'puddling' and a deterioration of condition.

In the case of areas where shade is less dense, and the cover of tea less complete, the position is rather different, and the chances are that deterioration over a number of years has brought the soil to a condition where it will respond to cultivation at the right season. Such soils having less protection and not being so fully occupied by root systems are more liable to lose their physical condition, and would respond to cultivation and especially to the addition of organic matter. Under these conditions there is every benefit to be derived from a well planned programme of soil cultivation. There is an old saying to the effect that ploughing should be done when the land is 'half wet, half dry'.

This is only an approximation, but may well form a guide to time of cultivation.

Another, and important, point in connection with soil cultivation is that of manuring. How far is forking necessary in the application of manures? It is, undoubtedly desirable that manures of all descriptions be mixed with the soil as well as possible, and it might be added, as evenly as possible in order that the maximum amount of soil may be explored by the root system of the crop. In the case of well protected soil organic matter added to the surface is gradually incorporated in the soil, though probably certain losses occur, especially of N. when incorporation is incomplete. To what extent these losses occur is not known. It may be said as a general rule that there is less need to fork in manures under protected than under more exposed conditions where it is undoubtedly advantageous to incorporate all manures with the possible exception of the immediately soluble types of artificial fertiliser. Very seldom in South India is anything but a mixture of artificial fertilisers used, in which case it is advisable that the mixture be incorporated in the soil. This should however be done when forking causes least disturbance of the actively feeding root system.

A consideration of the whole system of soil cultivation from the agricultural point of view leads one to several general conclusions. (a) That the need for cultivation will be less, the nearer the approach to jungle conditions—i.e. adequate shade, a complete cover of tea and the presence of ground covers; (b) that cultivation should only be done at a time when the roots of the tea bushes are not actively feeding near the surface, and when the soil is in a fit state for cultivation; (c) as far as possible organic matter should be incorporated in the soil whenever forking is undertaken.

Cover Crops and Green Manures.—The establishment of cover crops in tea is a marked feature of many estates, and provides a valuable safeguard against soil wash as well as being an additional source of organic matter to the soil. This practice would undoubtedly be considerably extended if a number of suitable low growing cover crops could be found. Many species have been tried but nearly all have the disadvantage of climbing through the tea. So far *Indigofera endecaphylla* appears to be the one really useful plant, but even this has disadvantages, since it is inclined to be rather too deep rooted at low elevations, and there is difficulty in establishment at the higher elevations, and it has a tendency to climb into the bushes.

Selective weeding is a common practice and has produced good results; were it not for the fear of grass becoming established selective weeding would almost certainly be a more general practice than it is. Of the many weeds common in tea areas, *Drymaria* is a useful cover.

From reports and discussions on the subject of green manures it appears that owing to the difficulty of establishment green manures are not very commonly grown in well established tea except in the first year after pruning when there is sufficient light to enable the plants to grow. Hedges of green manure crops grown at intervals in tea are of value in preventing wash and they afford a supply of organic matter.

It is felt that wider use could be made of green manures in waste land, and especially in large vacant areas in tea. If such plants were

grown wherever vacancies occurred, they would act as a protection to the soil, and by incorporation of cuttings in the soil an improvement in soil conditions would be obtained which would prove of great benefit when supplying is contemplated. The question of soil deterioration as a result of exposure has been dealt with above, and in vacant areas in tea green manures are to be recommended.

The establishment and vigorous growth of leguminous plants depend largely on the presence or absence in the soil of the nodule forming bacteria for the specific species of plant. To what extent the South Indian soils contain the required bacteria is not known. One must suspect that where the specific legumes have not been grown previously the required bacteria are absent. Legumes will grow without the required bacteria being present in the soil, but the main point in using legumes is lost if the bacteria are absent since without them, apart from growth being less vigorous, there is no accumulation of nitrogen from the atmosphere. At least one marked example of the absence of the required bacteria has been noticed in tea in South India. In this case *Crotalaria anagyroides* was planted in vacancies occurring in tea. In some cases the soil was inoculated by spreading on the surface and mixing with the top few inches of the soil the equivalent of 500 lbs. per acre of soil taken from an area in which *C. anagyroides* had been growing recently. In other cases no inoculation was done. The difference in growth was very marked, that in the inoculated areas being vigorous, and that in the untreated areas being poor.

Where legumes are grown and it is intended lopping them at intervals over a long period, the growth of the plants can best be maintained by only cutting back into young wood and not into the more mature wood.

In the case of most leguminous plants the soil is liable to become 'sick' to them after a number of years, in which case growth is very much retarded. This soil 'sickness' can be prevented by the use of different species of leguminous plants i.e. a rotation of legumes, and not continually using the same species.

Soil Erosion.—The prevention of soil erosion is a subject which has received wide attention throughout many countries in recent years. Owing to the nature of the soil, the climatic conditions and the condition of the land there is a very real danger of losing soil in South Indian tea districts. The danger of this, however, would seem to be fully realised by those engaged in the Industry, and the matter is receiving attention throughout the country. Various methods of preventing wash are employed according to the local conditions, and perhaps the one factor more than any other which is responsible for the prevention of wash in South India is the relative absence of clean weeding. The effect on crop of not clean weeding has not been worked out in South India—if, however, it should be found that crop is slightly reduced there is every excuse for continuing the practice of allowing a certain amount of weed growth on the ground that soil wash is being prevented; there is one other aspect of this subject the value of which cannot be fully determined, but is perhaps of great importance. With a permanent crop such as tea there can be no rotation of crops—an old established and sound agricultural practice—yet with shade trees, tea itself, cover crops, green manures and weeds we have growing in the soil a variety of plant life, each species feeding in

the soil in its own particular way. This represents a close approach to rotation of crops the difference being that there are a number of different plants growing in the same soil at the same time, instead of in a rotation. A reason for the rotation of crops is to keep a 'balance' in the soil which may be disturbed when only one species is grown continuously. By this mixture of different plants we can hope to keep a proper balance in our tea soils.

The use of contour hedges of plants grown in the tea, the use of drains, and terracing, are other widely used methods of preventing soil erosion.

J. D. MANNING

REPORT OF THE ENTOMOLOGIST

Advisory.—Most of the enquiries received during the year related to pests of Tea while some concerned those of *Grevillea*, *Albizzia* and *Gliricidia*. A small number of enquiries were also received in respect of certain pests of Rubber, Cardamoms and Cinchona.

Touring.—During July 1938, a tour lasting three weeks was undertaken in South Travancore mainly in connection with the problem of *Helopeltis* when six estates of the district were visited.

While in the Kalthuritty Valley during the course of the above tour, a short address was given to members of the Kalthuritty Club on the latest developments in the control of *Helopeltis* and other pests of tea.

In October 1938, a short visit was made to one of the estates in the Nilgiris to investigate a grass-hopper pest of tea. The observations made on the pest are briefly dealt with in a later section of the report.

TEA

Helopeltis.—During the year under report enquiries concerning this pest were fewer than in previous years but this fact is no indication that the situation regarding the pest has improved. A tour undertaken in South Travancore in the early part of the year revealed that the pest in that district was as serious as at any time before, and a report received from Mundakayam indicated that the pest had appreciably increased in that district during the year. It must be remembered that Mundakayam was a district in which only light attacks were experienced previously, and the above report is therefore to be viewed with anxiety.

Comprehensive reports were drawn up for the estates visited during the tour mentioned above, indicating the condition of the pest on each of the estates and suggesting measures, mostly of an indirect nature, that were likely to prove useful. No further investigation into the control aspect of the problem was possible during the year but a memorandum has been drawn up and submitted, suggesting the lines along which further investigations may be undertaken. It is hoped that opportunities will be available during the coming year for starting work on the lines indicated.

It may not be out of place to include a few remarks here on the question of the present position of the pest in South India. Although the pest is known to have been present in South India for many years, no records are available for gauging the situation in the different districts. What the condition of the pest was in each year and whether there has been any progressive increase in its severity and distribution as compared to conditions say ten years ago, we have no sure means of judging. Whatever information has been gathered is only through tours which have not been very frequent. Further, such visits made only to a very few estates in a district do not by any means give a true picture of the situation in the district as a whole, nor do the observations made at the time of

touring necessarily hold good for the entire year even for the estates visited. From occasional enquiries it is gathered that the pest has extended its range of distribution to areas which were hitherto considered free and also that severe attacks are experienced in places only lightly affected previously. We have, unfortunately, no information to what extent *Helopeltis* has spread, or whether the intensity of the attacks has increased. I feel it is time that we took stock and had a proper understanding of the situation. To achieve this, some form of questionnaire would be necessary and it is hoped that planters in the affected districts would co-operate in this matter and send in periodical returns. The data so collected would be invaluable, as they provide a ready means of knowing the severity of the pest in different districts and years and also indicate any extension to new grounds that may have taken place in any year.

Termites.—Enquiries relating to these pests were prominent during the year and, as pointed out in previous reports, the Anamallais probably suffer from their depredation to a much greater extent than any other tea district of South India. Through the courtesy of the manager of an estate in that district several collections of termites were received and five different species were represented in these collections. The specific identities of four of them have been determined while that of the fifth, which is a *Kalotermes*, is still pending. It is perhaps a new species. The identified species are as follows:—

1. *Coptotermes ceylonicus*, Hol. This species was reported as occurring on decayed jungle stumps and also attacking tea bushes killed by root disease. It has been reported in previous years from the Anamallai and Mundakayam districts and the observations made so far go to show that this is a species capable of attacking living tea bushes. Ceylon experience also points to the same conclusion. An account of this insect and the measures of control to be adopted in dealing with it are published in the *Planters' Chronicle* of 9th February 1935 (pp. 55-56- and in the Annual Report of this Department for 1935-36 (p. 36).

2. *Nasutitermes (Rotunditermes) anamalaiensis*, Sny. This species does not appear to be of much importance so far as tea is concerned, though it has been stated to form the nest at, or very near, the collar of the tea bush. Queens have been recovered from these nests but no damage to tea bushes has been noticed. It has also been found in leaf mould around a tea bush and from a living dadap. Whether the dadap plant was attacked by the termites is by no means clear and definite information on this point is lacking.

3. *Nasutitermes (Subulitermes) horni*, Wasm. Its status is perhaps the same as that of the preceding insect. Though reported as occurring in tea bushes it is pre-eminently a termite of the scavenging type not likely to cause material damage to living tea bushes.

4. *Termes anamallensis*, Hol. This termite was reported to have been found in a living tea bush six inches below ground. The centre of the bush was stated to have been hollowed out, the bush to all outward appearances looking perfectly healthy. Living Dadap trees also seem to be attacked by this species, report having been received of its damage to Dadap which had been eaten into at a height of about 3 feet above

ground. The capability of this termite of attacking living plants, however, requires to be confirmed.

5. *Kalotermes* (*Neotermes*). Sp. This is to be regarded as the most serious of the termites as it is capable of causing considerable damage to living tea bushes. It is so far known only from the Anamallais and although reports of its damage are often received, precise knowledge of the position of the pest in the district and of the extent of its depredation is still lacking.

Another termite of the family *Kalotermitidæ*, quite distinct from the above, was reported from an estate in South Travancore. It was at first thought to be one of the species of *Kalotermes* occurring on tea in Ceylon, but a closer examination revealed that it was not referable to any of the Ceylon forms. The authorities of the Imperial Institute of Entomology who examined the material sent to them have placed it in the sub-genus *Kalotermes* of the genus *Kalotermes*, indicating at the same time that it is probably a new species. The damage done to the bush by this termite resembled that caused by *K. militaris* of Ceylon. This is the first instance of *Kalotermes* damage recorded from South Travancore. Although it may not be wide-spread at present, still this is an insect whose activities require to be carefully watched.

An article purporting to convey an idea of the life-history, habits and social economy of termites in general was published in the *Planters' Chronicle* during the year.

Leaf-Rollers.—The two leaf-rollers of South India, viz., *Laspeyresia leucostoma* and *Gracilaria theivora*, were little in evidence during the year under report. They were each reported once, the latter, however, as causing extensive damage to tea in Mysore. Though they have a wide range of distribution in South India, their attacks are generally of sporadic occurrence and the prolonged drought experienced during the year was probably the limiting factor for their normal multiplication.

Grasshopper.—This pest which has been identified as *Orthacris incongruens*, Carl., was reported to have become serious during the year on an estate in the Nilgiris. A visit paid to the estate gave the opportunity of observing the pest in the field and also to discover its egg-laying habits.

At the time of the visit the pest was not very prominent and it looked as if its season of active depredation was drawing to an end. This was attributable mainly to climatic conditions having a bearing on the seasonal history of the pest and, to a less extent, to the prevalence of parasites in the form of fly-maggots. These latter were found infecting a large percentage of hoppers collected at the time and the adult flies too were in evidence hovering about in the infested area.

The egg-masses were discovered in the soil at the base of the tea bushes and this fact prompted a suggestion to be made that forking might perhaps be a useful measure to employ, as it would either expose the egg-masses to the heat of the sun and predatory birds or bury them deeper, in both cases preventing their hatching.

The poison bait consisting of bran, Paris Green and molasses, usually employed against grasshoppers, did not seem to have been effective in dealing with this pest and trials were therefore intended to be made in the laboratory with a view to find out a suitable bait acceptable to the insect. A collection of hoppers was made for the purpose but as the insects were mostly parasitised it was felt that trials with them would not give reliable results. It is intended to carry out these trials when suitable insects become available.

The observations made in the field did not indicate that the pest came in from any grassland. It was thought therefore that the pest had multiplied in tea itself for a number of years, its presence remaining unnoticed during early years when its population was but small.

The seasonal history of the pest still requires to be determined. Accurate information as to whether one or two broods occur in a year should materially help to determine at what time or times of the year control measures can best be undertaken.

Cutworms.—This pest was reported as attacking very young tea plants. Depending on the severity of the pest in each case, hand-catching, trapping or the employment of baits was recommended towards control and presumably, the pest was brought under control by the adoption of one or the other of the above measures.

Maggots in Tea Seed.—Several reports of tea seed which had failed to germinate or grow properly were received from various estates. Although maggots were found infesting most of the decayed seeds, it was considered that they had gained entry into the seed subsequent to decay caused by other factors. This conclusion was supported by the fact that the maggots were not all of one species in the materials examined but represented diverse species. It seemed most unlikely that several different species could attack healthy seeds under natural conditions. In one instance adult flies could be bred out of maggots and they have been identified as *Limonia (Libnotes) punctipennis*, de Meij, (Tipulidae). It is apparently a new insect so far as tea cultivation is concerned and although the family to which this insect belongs contains injurious insects causing damage to grasses, cereals and garden plants in temperate regions, the habits of this particular insect are little understood.

Nettle-grubs.—As in the previous year, there were no reports of Nettle-grubs on tea in the enquiries received from estates, though this cannot be taken to mean that they have ceased to be of importance. They are generally of sporadic occurrence and appear suddenly in very large numbers over several acres. Such instances have been recorded in previous years and the damage during such outbreaks was indeed very great. The first few broods are apt to be overlooked, and when the pest is actually noticed, it will be found to have spread over large areas rendering the task of control difficult. The recognition of the pest in its early stages is therefore of utmost importance and with this object in view, if the estate labour such as kanganies and plucking coolies are told to report at once whenever they notice these pests in the field, a systematic search may be ordered and the pest controlled. Also, during dry weather

forking, the bases of bushes in suspected fields may be searched for any cocoons found in the soil. If these precautions are taken it is very rarely that pests of this kind would make themselves seriously felt.

Scolytid borers.—*Xyleborus semigranosus*, Bldf. was reported as attacking tea in Nilgiri-Wynaad. The infestation was not of a serious nature and an examination indicated that it was most improbable that this borer could have caused the death of the bush. It was inferred that the bush was in a weak and unresistant condition at the time of attack by the beetle and the suggestion thus made was corroborated by the subsequent discovery of a root disease. The latter was primarily responsible for the trouble and the insect which is generally a borer in moist wood had subsequently gained entry into the bush. This insect is also known to attack *Albizzia* spp. and *Grevillea*.

Xyleborus fornicatus, Eich., the true shot-hole borer, which was hitherto found only in Central Travancore as attacking tea, was noticed for the first time on an estate in South Travancore. Whether other estates in the latter district are also affected and what position this insect now holds in South India generally are points on which definite information is lacking.

Scale-Insects.—The scale-insects that came under notice during the year were (1) *Lecanium hemisphaericum*, (2) *Chionaspis biclavis*, (3) *Hemichionaspis theæ* and (4) an unidentified Lecanine scale. While the first named can often cause serious injury to infested plants, the damage due to the last three insects is generally negligible and does not warrant the adoption of any control measures. *L. hemisphaericum*, when it threatens serious damage, may be dealt with by spraying or brushing the infested plants with any suitable contact insecticide such as kerosine emulsion or Fish-oil-resin soap.

Red Coffee Borer (*Zeuzera coffeæ*).—This pest was reported from the Anamallais and the High Range. While its attack may often be felt severely by young plants, older bushes rarely suffer loss of more than a branch or two. The insect has a wide distribution in South India but the damage caused by it is not serious. Its status is only that of a minor pest. Special control measures other than cutting off of the attacked branch and the destruction of the borer inside are, however, largely unnecessary. In cases where the injury has extended below the ordinary pruning level, the galleries may be probed with a wire so as to kill the inmates or a piece of cotton wool soaked in carbon bisulphide inserted. Alternatively, a small quantity of petrol may be injected into the gallery and the opening plugged.

Eelworms.—Enquiries concerning eelworms were prominent during the year. Both *Heterodera marioni* and *Anguillulina* sp. were common. In addition to tea, eelworms were also found to infect *Grevillea*, *Albizzia* and Red Gum seedlings. To safeguard against eelworm infection in tea nurseries a large number of soil and weed samples from proposed nursery sites were examined for eelworms for a neighbouring estate and treatment of the soil with 1% formalin solution was suggested in the cases of soils suspected to harbour the pathogenic species. The suggestion has been carried out but the results have not yet come to hand.

Rats and Porcupines.—Field rats were reported as causing damage to young tea plants in Nilgiri-Wynaad. The attacked plants had been killed as a result of their roots being completely gnawed.

Pumping cyanogas into the burrows is about the best method for controlling this pest, though good results may also be obtained by the use of a poison bait. Any of the chemicals, Sodium arsenite, Barium chloride, Zinc phosphate or Strychnine may be employed usefully in the preparation of the bait which is spread around the plants in the infested area. The last named is extremely poisonous and must be used with very great caution.

Experience in other countries has shown that when the infested area is overgrown with any green manure or cover plant such as *Crotalaria* or *Centrosema*, attacks could be minimised by cutting back such growth and then employing a poison bait. It is believed that plants in open beds are not attacked to any great extent. It is again possible that a disturbance of the soil by means of deep forking might tend to expel rats and an experiment in this connection might be worth a trial.

Porcupines were the subject of an enquiry from the High Range. These animals too may perhaps be controlled in the same way as rats by using a poison bait. Clearing away the jungle surrounding the nursery is also said to afford a fair measure of relief from them. In view of the gregarious habit of porcupines their warrens may often be traced within a few yards of each other from which they may be dug out. The adoption of a system of offering a reward for the capture of porcupines is said to have brought about in some cases considerable reduction in their numbers.

GREVILLEA

No serious pest of this tree came under notice during the year except a single instance of attack of eelworms on seedlings. This report is of interest as it is the first instance of eelworm damage to *Grevillea* noticed by this Department. This would indicate that *Grevillea* too is susceptible to eelworms.

ALBIZZIA

Xystrocera globosa, a Cerambycid borer, was reported as attacking *Albizzia moluccana* in Peermade. The attacks were associated with cankers on the main stem and the trees were said to be dying out in large numbers. Whether the death of the trees was primarily due to this borer or to any fungal disease has not been determined with certainty. It is known, however, that, as a result of borer attack, weakly and less resistant trees may be killed in one season. Whether the trees were in this condition and if so what were the factors tending to debilitate the health of the trees still require to be investigated. An allied borer, *X. festiva*, is known to attack *Albizzia* in Java but rarely does the attack result in die-back. The cambium and the sapwood may be completely eaten away in patches thus arresting the flow of sap in these regions. Complete 'ringing' of the stem is rarely noticed and it is said that the damage from a single attack limits itself in most cases to the formation of a weak spot in the stem or thick branches which may, however, get broken during a strong wind.

The exact role of *X. globosa* in the disease and death of *Albizzias* still remains to be determined. Pending such an enquiry it seems unwise to neglect the damage caused by the borer and steps have to be taken to destroy the grubs working in the stem. A 10% solution of Paradichlorobenzene may be injected underneath the bark of infested trees as this appears to have given very satisfactory control in Java by killing all the grubs. Care should, however, be taken to apply the solution to the infested areas of the stem only, as Paradichlorobenzene also kills the cambium. A good callus growth is reported to take place subsequently, largely compensating for any death of the cambium that may result at the time of application.

A Membracid bug (undetermined yet) was also reported as occurring on *Albizzia* in conjunction with the borer dealt with above. The bugs were confined to terminal branches or leaf-bearing shoots on which numerous slits were made for introducing the eggs. The eggs were laid in a characteristic manner. As a rule, the damage caused by these bugs is not of great importance; nevertheless, when they are very numerous as in the case reported, the feeding of large numbers of nymphs and adults together with the egg-slits cannot but injure the young twigs.

Terias (yellow butterfly), eelworms and jungle sheep formed the subject of other enquiries regarding *Albizzias*.

GLIRICIDIA

An unidentified Hepialid borer was reported as causing damage to this tree in South Travancore. The borer was stated to have completely 'ringed' the tree to a depth of about a quarter of an inch and then to have bored down into the pith to a distance of about 6 inches, thus cutting off all supply to the tree which had consequently died above the point of attack. As with a similar borer which attacks *Casuarina*, Red Gum and occasionally tea, control may be obtained by (1) introducing a liquid insecticide such as Carbon bisulphide into the tunnel and plugging the entrance hole and (2) removing and burning all dead and dying plants thereby eliminating the caterpillars and cocoons present in them.

MISCELLANEOUS

In addition to the above, a number of miscellaneous enquiries were dealt with. A few of these related to Cardamom, Rubber and Cinchona, of which mention may be made of the following: *Dichocrosis punctiferalis* (borer) and *Eupterote* sp. (caterpillar) on Cardamom, a Lecanium scale on Rubber and Sphingid and Psychid caterpillars and a Fulgorid bug on Cinchona.

Red Gum seedlings were attacked by eelworms in the High Range and a borer was the cause of some damage to young *Casuarina* plants in South Travancore.

An insect stated to have been found in a live condition in London in a chest of tea despatched from an estate in South India was received for examination. As it was in an immature stage an identification could

not be made nor could it be stated definitely whether it was a common insect in South India.

Beetles of the family Passalidæ were reported as occurring in dead wood all over the High Range. Members of this family generally live in small colonies in rotting stumps, the larvae, pupae and adults being found together. These beetles are of interest in view of the parental care they exhibit, the degree of social organisation they have attained and their powers of stridulation, but economically they are of little importance.

Several proprietary insecticides were received for trial and a few enquiries were made of others with a view to their possible adoption against any of the pests of tea or other plants. Advices were also sought for the preparation on the estate of some of the common insecticide sprays.

In the absence of the Mycologist from the Station, the mycological specimens received during the year at the Station were examined and advices given as far as possible. During the absences on tour of the Tea Scientific Officer the routine work of the Station was attended to.

Collection of insect specimens for an Exhibition proposed to be held at the time of the next Annual General Meeting of the U.P.A.S.I. has been taken in hand. Some time was spent on this as also on the collection, preservation and naming of plant specimens for the same purpose.

Acknowledgments.—My thanks are due to the Managers of estates visited for the assistance given me during my stay on their estates.

Grateful acknowledgments for assistance in the identification of insect specimens are made to the Director of the Imperial Institute of Entomology, London, and to the Entomologists of the Tea Research Institute, Ceylon, the Forest Research Institute, Dehra Dun, and the Agricultural Research Institute, Coimbatore.

S. ANANDA RAU,
Entomologist.

REPORT OF THE MYCOLOGIST

Correspondence.—During the year under review 127 letters were received and 146 letters despatched.

Advisory.—The number of specimens received shows a slight decline, but enquiries without specimens accompanying them were more frequent, these relating in general to control of diseases. Shade trees and their diseases have been receiving greater attention than in previous years. The *Grevillea* leaf disease has become very prominent during the year. Of the tea diseases attacks from *Asterina camelliae* were frequently reported.

Touring.—To investigate into a die-back and canker disease of tea on some of the estates in South Travancore I took up residence at the Poonmudi Estate during the middle of May and have continued investigation there up to the time of writing. The disease under investigation is widespread in South Travancore.

During February 1939, on the report of the occurrence of a die-back and canker disease of *Albizzia moluccana* on some estates in the Peermade District I proceeded to the district to investigate and at the same time took an opportunity to go into the question of a die-back disease of tea on an estate in the Vandiperiyar District. The results of the investigations made during these visits are included here.

TEA

LEAF DISEASES

The Black Blight disease has been the most prominent of the leaf diseases of tea, followed to a lesser degree by the *Cercospora* disease. In the absence of information about the other diseases no comment as to their seriousness seems justified. All the diseases so far found in South India have been dealt with in the earlier reports of the Department, but because of certain misconceptions about the Black Blight attack this disease is again referred to in the present report. Information on this disease is also to be found in the Annual Report for 1937-38.

Black Blight (*Asterina camelliae*).—It was stressed in the earlier report on the same subject, that the cause of Black Blight is entirely different from that of 'Sooty mould', though there is a similarity in the external appearance of the two diseases. The association of insects or their exudations in the latter case requires to be stressed. As it is, however, difficult to distinguish between the two diseases by a superficial examination it is necessary to have specimens examined before undertaking any control measures, where such measures are deemed to be necessary. Ordinarily, no fungicidal application appears to be required against Black Blight outbreaks, and the destruction of insects that exude sweet fluids on which the sooty mould organisms feed is to be aimed at in dealing with the other apparently similar disease (Sooty mould). Reports were received during the year that the Black Blight has tended to extend to

areas that were previously free. On this information, and because of the rapidity with which the spread appeared to have taken place, suggestions were made to spray the affected bushes with Bordeaux mixture. As yet the results of the application and the status of the disease in the district are not available.

An opportunity occurred to observe the disease (Black Blight) on an estate; it was found that the fungus attacked bushes towards the end of the pruning cycle, and during the rainy season. The possibility that hanging mists may have some influence on the incidence of the disease is suggested. When mists are uncommon the tea is apparently less affected. Hide-bound and debilitated bushes are more susceptible.

During the dry weather that ensued after that attack none of the bushes earlier attacked showed any serious after-effects of the disease. As indicated in the earlier report, the effects, if any, are probably of a cumulative nature.

STEM DISEASES

Die-back and Canker

Introductory.—According to the programme laid out in the Annual Report (1937-38) of the Department I was asked to proceed to South Travancore for the investigation of the Die-back disease prevalent on estates. Accordingly, the investigations were begun on the Poonmudi Estate, and the work so far done on the subject is summarised here.

To give a brief history of the problem, it is necessary to refer to some advisory correspondence based on examinations of specimens received from some of the estates in the district. Judging by the damage found, and in the absence of any pathogenic agency on any of the specimens received at various times, a suggestion was made that the damage resembled closely that caused by the Pink Disease fungus—*Corticium salmonicolor* B. & Br. Beyond the necessarily vague suggestion as to the probable causal organism no definite diagnosis was at that time possible. The present investigation has indicated the absence of the Pink Disease organism on the damaged shoots on the estate on which the investigation is in progress. The only instance of Pink Disease was discovered on a few branches of a *Grevillea* tree and on these all the characteristics of the above disease were evident. Pink Disease has not so far been noticed on any of the other *Grevilleas* or in the tea or on any other host plant.

Symptoms and Damage.—The damage in the disease under investigation shows itself in the form of dry shoots with yellow or brown foliage, depending upon the degree of the progress of the disease. Invariably, as in the case of other canker diseases, the branches show numerous gnarled cankers along their length, these being either continuous or in patches. The bark instead of retaining the healthy colour of red wood becomes dirty brown and as a result of the canker growth is disrupted on the surface. The yellow leaves gradually turn brown and ultimately die. These symptoms are more conspicuous during dry weather than during the wet period. During the monsoon marked symptoms are absent,

although careful search reveals shoots in various stages of cankering. However, during the short spell of fine weather that generally follows a continuous wet period, a certain amount of yellowing of the foliage is occasionally noticeable.

The size of branches attacked does not exceed pencil thickness. Both green shoots and red wood are susceptible. On green shoots the attack is seen in the form of small areas of discoloured bark between two nodes. Usually, the damage appears to start at leaf-scars but infection at other parts of the stem may take place at wounds caused by plucking or tipping. Sometimes, the cankers develop from the axils of branches and extend over a part of the new green shoot arising therefrom. The cankered areas are weak and when dry, infected shoots break off easily from the parent branch.

Seasonal Activity.—Because of the conspicuous discolouration that is noticeable during the dry season the prevalent opinion is that the disease is a dry weather one; actually, during this period the fungus is either entirely absent from the damaged shoot or is in a very inactive condition. Evidence so far collected suggests that the associated fungus is active during part of the rainy season. In fact the fungus has been found to produce one of the forms of its spore bodies abundantly during the earlier part of the rainy season, the second form being produced later on. The activities of the fungus are therefore confined to the wet weather, although its effects become manifest considerably later, i.e., during the dry weather.

During the early part of the investigation, viz., May and June, the following organisms were present on the diseased cankered shoots:—

Nectria hæmatococca Berk & Br. Syn.: *N. cancri* Rutgers.

Calonectria rigidinacula (Berk. & Br.) Sacc.

Nectria subquaternata Berk. & Br.

Colletotrichum camelliae Massee.

Cephaleuros Sp.

A fortnight after the advent of the rains, an imperfect fungus made its appearance on the diseased shoots. This fungus was of a pale pink colour appearing on the bark in the form of small cushions. Large numbers of these cushions were produced during the early rains but their numbers decreased considerably when the rains became more continuous and heavy. Over the regions occupied by the pink conidial cushions small pale flesh to light salmon-coloured spherical masses of perithecia developed subsequently. During the dry weather similar bodies had been seen but as they were empty no identification was then possible. Because of the variable indications in the matter of the septation of the spores and also because of the dissolving asci, the identification of the perithecial bodies remained for a long time in considerable doubt. Subsequently, however, when mature ascospores were found in the asci, the fungus was identified as *Nectria subquaternata* Berk. & Br.

As the latter fungus—*N. subquaternata*—and its conidial form mentioned earlier were the two survivors on the advent of rain, and because

of the two organisms being in association with all fresh instances of attack, it is considered that these two fungi are responsible for the damage.

The other organisms listed above were much less frequent, being found only on shoots attacked earlier.

The conidial form could definitely be traced to *N. subquaternata*. A brief description of the two forms of the fungus is given here, as it is understood that *N. subquaternata* has not yet been described in the literature on plant pathology and no mention of its conidial form has previously been noted.

Conidial fructification.—The fructification is produced on the surface of the bark, as small cushion-like masses about 1 to 2 mm. in diameter. Sometimes the growth is tubercular appearing to burst through the bark. The mycelial threads are colourless but when in a mass they have a light pink colour. The conidia are produced on the surface of the cushion on long stalks which carry the conidiophores. Conidiophores are verticillate, with a slight bend at the point of origin, and pointed at the free end. Each conidiophore measures from 1' to $24.5 \times 1.5 \mu$. Conidia are abstricted from the tip of the conidiophore individually without the formation of any chain-like structure; are hyaline (colourless), irregularly spherical to more or less cylindrical (the latter predominate), ends are rounded, measuring from 3.5 to 5.25×1.5 to 2.0μ . Variations in shape occur to a considerable extent, the more cylindrical ones being often slightly curved.

Perithecial fructification.—These are formed either on the surface of the bark or beneath it, in which latter case they appear as if bursting through it. Salmon to pale flesh-coloured, occasionally solitary but more often aggregated in groups of 4 or 5. Perithecial wall fleshy, composed of angular cells. A few perithecia have been found to be warty on the surface but this feature was not very common. The stoma (mouths) are depressed in the centre. The individual perithecia measure about 0.3 to 0.4 mm. in diameter. Asci are thin-walled, diffuent (dissolving), clavate, with eight spores, from 52.5 to $56 \times 6 \mu$, momostichous: or, distichous when about $40 \times 10 \mu$. Spores are smooth and hyaline, at first fusoid with rounded ends and very indistinctly uniseptate; later, oval or oblong and distinctly one-septate, slightly constricted at septum, from 8 to 12.5×2.5 to 3μ . Non-paraphysate.

Saccarado describes *Nectria subquaternata* B. & Br. in the following terms (*Sylloge fungorum*, vol. 11, p. 489):—

'Subcæspitosa, pertheiciis pallidis opacis;'

'oblongis submetulæformibus, uniseptatis,'

' 12.5μ longis. Hab. in corticibus, Ceylon,'

'—Perithecia sæpius, 4-5 aggregate, centro,'

'depressa.'

In the Enumeration of the fungi of Ceylon Berkeley and Broome refer to this as follows:—

'No. 1026—*Nectria subquaternata*.'
 'Subcaespitosa, peritheciis pallidis opacis,'
 'sporidiis oblongis submetulaformis uni-,'
 'septatis. On bark. Often 4 or 5 together,'
 'with a depression in the centre.'

Neither of the authors has presumably seen the conidial stage of the organism.

Because of the asci. being diffluent even at a very early stage in the formation of the spores, the identity of the organism remained for long obscure. In the absence of the uniseptate spores in the earlier examinations when perhaps they were still undeveloped, the fungus appeared to agree in some respects with the description of *Hyponectria*.

As single ascospore cultures have consistently produced only the microconidial form described above there is reason to believe that there is no macroconidial stage belonging to *N. subquaternata*, as is common with many other species of *Nectria*.

The other organisms mentioned in the list were mostly found on old attacks and they are therefore considered to be of secondary importance. To enable, however, their recognition in the field brief descriptions of these organisms are given below.

The colour of *Nectria haematococca* is distinctly redder, and this fungus is only rarely seen in association with the die-back shoots. That this species of the fungus is responsible for some damage by causing similar die-back and canker elsewhere is recognised but in the present investigation this did not appear to be of much importance. Its macroconidial stage *Fusarium* has occasionally been seen on the surface of the bark of woody branches.

Calonectria rigidinacula is distinguished from the others by its whitish to yellowish white perithecia. This was found on old shoots sometimes in association with, but often independently of, *N. haematococca*. This fungus has often been observed on old cankered branches. There appears to be a *Fusarium* associated with this fungus.

On die-back shoots and beneath their disrupted bark *Colletotrichum camelliae* was often seen during the dry weather. The conidia were being discharged in the form of pinkish tendrils. This fungus did not differ much from the Brown Blight fungus of tea. Occasionally its perfect form—*Glomerella cingulata*—was also observed.

The algal rust (Red rust) *Cephaleuros* sp. was another of the common organisms on the disrupted bark but its presence was not considered to be of any particular importance as the alga was common on most plants that were believed to be lacking in vitality, as a result of serious attacks of *Helopeltis*.

Helopeltis and Die-back.—It is held in some quarters that attacks of *Helopeltis* help to spread the organism causing the disease. Although attack by *Helopeltis* seems capable of causing some amount of die-back, especially when the new shoots are developing after pruning, no positive evidence establishing relationship between the insect and the fungus was forthcoming. Instances where in spite of severe insect attack the bushes were free from die-back symptoms or the organism, and conversely, examples of bushes suffering from die-back but with absolutely no indication of *Helopeltis* bites were abundantly available. Moreover the attack of the insect is confined to the leaves and succulent shoots and does not descend to the redwood shoots, where the canker occurs. The above evidences do not lend support to the view that the insect attack and the incidence of die-back are correlated. It is probable that these two factors are independent of each other.

Pruning and Disease.—The disease seems to be at its worst during the first year of the pruning cycle, appearing about six to eight months after pruning. The intensity diminishes the further the tea is from pruning. Because of the advantages of dry weather pruning in relation to *Helopeltis*, most of the pruning is done during the dry months from late October to early March. The very disastrous results of pruning during the monsoon which were noted on a part of the field chosen for experiments is sufficient to warrant an acceptance of the beneficial results of the current policy. It must, however, be said that, added to the time of pruning, the lie of the land exerts considerable influence over the subsequent incidence of *Helopeltis*. Pruned at the same period, tea in the more open areas appeared to have escaped the *Helopeltis* while that in the hollow places never succeeded in its attempts at growth because of successive attacks of *Helopeltis* on the young buds.

In one area, pruning during February-March has been followed by freedom from die-back, but as the disease was generally light during the year, further information in confirmation of this observation is needed before suggesting any change in general policy. It may, however, be mentioned that the particular field under discussion was reported to be one of the worst affected areas both from *Helopeltis* and Die-back.

Low and heavy pruning, resulting in the development of shoots at almost ground level, appears to encourage the disease. There was ample evidence in support of this. Higher pruning, and therefore a distribution of growth over a larger area, has an inhibitory effect on the disease. Two contiguous blocks of tea, one pruned hard and the other lightly, show by contrast the comparative benefits of the latter system of pruning. Also, it must be mentioned that the greatest incidence of the disease and of *Helopeltis* attack have occurred in an area that has been pruned hard. Other conditions being uniform and with a good jat of tea, perhaps a higher pruning table would be of advantage from more than one stand-point.

Mode of Infection.—One common method of infection that was observed was through the leaf-scar. The fungus was also found to gain entrance through any open wound caused either by tipping or plucking. The majority of infections were through the first of these, viz., the leaf-scar.

The causes of defoliation which affords weak points for the entry of the organism are not definitely known, but in an area that had been under

observation all infections that were recorded resulted after a large incidence of leaf-fall. There was a very wet spell associated with high winds and it was at such a time that quite a good percentage of the bushes were found partially denuded of their foliage. The infections took place about a fortnight or so after partial defoliation was observed. There was no reason to believe that the physiological condition of the bush had anything to do with the observed leaf-fall. Starch determination carried out failed to explain satisfactorily the leaf-fall.

Another possible factor that still requires confirmation is the after-effect of drought. This year has been exceptionally dry and the tea in some parts of the estate appears badly hit on account of the drought; how far the drought-affected bushes react to the later incidence of die-back requires to be investigated by observations on these areas. It is possible that the ebb of vitality during this period renders the bush more susceptible to disease immediately the rains start.

Other Factors.—The disease as stated earlier occurs sometime about six to eight months after pruning. There is no definite evidence to suggest that the attack starts after any particular normal field operation. It was at first thought that the infection started after tipping, but later observations did not lend conclusive support to this assumption.

The possibility of lack of vitality in bushes rendering them susceptible to attacks has been suggested and to ascertain this, various experiments in the form of resting, manuring and cultivation have been planned and some of these are already in progress.

Starch Reserves.—Apart from the determination made to explain, if possible, the cause of defoliation, attempts were also made to test for starch, root samples taken from some of the heavily infected tea. This tea, it must be mentioned, although about eighteen months from pruning, has not so far yielded any crop. *Helopeltis* is a constant feature and is to be found all through the year. The *jat* appears to be a small-leaved 'China' which suffers severely from die-back. The rough determination of starch as described by Tubbs and Tunstall was adopted for the present tests.

STARCH DETERMINATION IN ROOTS FROM FIELD 'B'

Per cent ...	...	0	10	20	30	40	50	60	70	80	90	100	No. of samples
No. Healthy	...	..	2	3	4	...	11	...	...	...	...	...	20
No. Diseased	...	8	12	8	9	7	6	...	...	...	...	...	50

It will be evident that neither in the healthy ones nor in the definitely diseased ones was there any adequate starch reserve. The healthy ones could not properly be called so, and in fact they are to be classified as 'apparently healthy'.

This test has suggested the need for rest which while improving the general health of the tea, should help to minimise the incidence of the

disease. It is proposed to lay out experiments on the time, duration and best form of resting; some of these are already in progress but results are not yet available.

Cultural Work.—Isolations of the organisms associated with the disease were obtained with success. The pure cultures so obtained were employed for the infection experiments and for studying the life-history. Except *Colletotrichum camelliae* which readily produced its perfect form on agar slants, the other organisms have produced only one or more conidial forms. *N. hæmatococca* and *C. rigidinsecula* have successfully given the macro- and micro-conidia. *N. subquaternata* has only produced a microconidial form whether asco- or conidio-spores had been employed in its isolation. On steam-sterilised shoots none of the three organisms has given their perfect form. On green, surface-sterilised shoots *N. subquaternata* developed both the imperfect and the perfect forms whether the conidia or the ascospores had been employed for inoculating the shoots. The perithecial form of this fungus developed after nearly three months from the date of inoculation. Comparison of these artificially produced forms with their natural forms did not show any marked differences. The results have served to establish the relation between the two forms of the *N. subquaternata* and also to confirm the field observation in the absence of a second or macroconidial stage so common on some of the other well-known species of *Nectria*.

Inoculation Work.—Several inoculations carried out under varying conditions with both natural and cultured material have not met with success. Consequently, the pathogenicity claim has to depend on the extensive field examinations carried out when the disease was most active. *N. subquaternata*, of all the organisms, was the one fungus found constantly in association with the disease.

The reason for the failure of any of the inoculations may be due to the following causes:—(1) The unsuitability of the plants employed. Plants about two years from pruning were trimmed to give a limited number of branches and then left to grow for a time in order to obtain sufficient growth of green shoots. The leaves were plucked off just prior to inoculating the shoots so as to bring about conditions as near to natural as possible. In spite of these plants being watered they showed no response to the inoculations. It is possible that the plants selected were not quite suitable. The potted plants would probably have been more suitable but as they had not made good growth, the above was tried without any success. (2) The spells of dry weather that intervened at short intervals are probably another cause of the failure. As the disease under normal conditions appears mostly on first year shoots, the first of these causes may be primarily responsible. It is hoped, however, that during the ensuing rainy season inoculations under more favourable conditions would throw more light on the question.

Control measures.—(a) *Preventive.*—Spraying with Bordeaux mixture as a preventative was being tried at the time the investigation was started. No satisfactory results were observed from this spraying, the disease appearing in almost the same degree in the sprayed and control plots. From an experimental point of view it seems that the site selected was not all that could be desired. However, without going further into the results of this experiment it must be stated, that, the part to be

protected against the disease is the shoot and to spray this part effectively, after the growth of foliage has taken place sufficiently to conceal it, is by no means easy. It appears that in the case of tea the period when it could effectively be sprayed is of a very short duration.

(b) Direct control measures were put into effect on one of the very heavily infected areas during the latter part of January, 1939. Attempts were made to cut out all diseased shoots that had either completely died or on which canker growths were seen and on which the foliage was beginning to go yellow. The shoots were cut back to healthy wood to eliminate as much of the source of infection as possible. The operation was repeated a second time during which a comparatively small number of diseased shoots were found. The collected shoots were weighed before being burnt. Because of the long period of drought more shoots have been dying out at intervals, but the cause of these deaths has not always been due to die-back infection.

The fresh growth that has appeared after the above treatment, is free from disease but the field is to be kept under observation during the rainy season when attacks generally become prominent in the form of fungal growth. Incidentally mention must again be made of the presence of *Helopeltis* on the new foliage.

As it is believed that the disease is associated with the debilitated condition of the tea it is considered that all measures undertaken to improve the vitality of the bushes would help to reduce the incidence of the disease. A few experiments that have been laid out to elucidate the above point have already been dealt with briefly.

Die-back of Shoots and Pruned Branches.—*Megalonectria pseudotrichia* (Swein) Speg. and its conidial form *Stilbum cinnabarinum* Mont. have been found on tea branches. The conidial form was found growing on the surface of the bark of dead woody prunings and on the pruned primary branches. The conidia appeared on small yellowish red stalks (conidiophores) in the form of heads, the entire structure closely resembling a drumstick. The wood in some of the cases examined indicated a slight discolouration, but this was not a constant characteristic. Its occurrence on some live parts suggests the possibility of the fungus being a wound parasite. The perfect stage viz. *Megalonectria* is also produced on the bark, presumably at the base of the conidiophore. Often the perithecia have been found to carry at their extremity the stalked synnematus conidiophore. The former is of a dark red colour.

It is reliably understood that this fungus is referred to as and mistaken for Pink Disease probably because of the colour of the fungal growth. The Pink Disease fungus is of a much lighter colour than either of the stages of the fungus now under discussion. It must be impressed here that Pink Disease and *Megalonectria* or its conidial form have nothing in common. The Pink Disease fungus is entirely parasitic while the fungus that is described above is at best a wound parasite incapable of infecting sound tissue.

Isolations made from both the forms of the organism have resulted in the development on agar slants of dark red masses of conidia without the stalk.

As at present known the damage caused by this fungus is not of a serious nature, occurring only occasionally on pruned branches and woody shoots taking their origin from about the collar region. It would therefore appear sufficient if the affected shoots are cut back to new wood.

Die-back of Shoots after Pruning (*Leptothyrium theae*).—The fungus associated with this disease is known by the name *Leptothyrium theae* Petch., having been described first in Ceylon. In South India this fungus came to be observed during April 1938, on specimens received from an estate in the High Ranges. Subsequently, the disease was noticed on tea in the Vandiperiyar District as also on an estate in South Travancore.

Observations here have revealed the following facts: The fungus attacks young shoots developing after pruning. In the present instance, the tea was about six months from pruning. Foliage of affected shoots becomes yellow, gradually turns brown and dies. Green shoots also turn brown. No visible damage in the form of cankers is apparent, but at the base of the attacked shoots a ringed appearance may be noticed. The surface of the bark a little above the base shows numerous tiny pin-head like outgrowths rendering the bark slightly uneven. These pin-heads indicate the point of origin of the fructifications of the fungus that lie buried beneath the bark.

In the field the pin-heads have been seen to throw out in the form of fine greyish tendrils the spores of the fungus even under very dry weather conditions. But in the laboratory such extrusions have occurred only when the material was placed in a damp chamber. Because of the availability of good fructifying material, opportunity was taken to have some of the samples sent to the Mycologist of the Tea Research Institute, Ceylon, to obtain a confirmation of the diagnosis, which he has kindly done.

The disease became apparent during the dry weather and the collapse of the infected shoots was rather rapid. In Ceylon, death of bushes as a result of the fungus ringing the collar has been reported but no such serious result has yet been noticed on the estates reporting the disease in South India. In the one instance where close observation was possible the tea affected was in a rather hide-bound condition, and in the majority of cases only a few shoots were involved, the rest being healthy. At present this disease does not appear to be of a serious nature but it may assume more importance if not controlled in the early stages.

The shoots attacked by this fungus were cut out by knife, and along with the diseased shoots a part of the healthy bark from the parent branch was taken out by judicious peeling with the same instrument. Should it however show a tendency, as in Ceylon, to descend and attack the collar, pruning back all the diseased parts is the only method available in dealing with the attack.

Isolations from the spores have only given their vegetative growth in the form of greyish-brown mycelia.

ROOT DISEASES

There is nothing new to record under this head. The idea that liming is a useful preventative for root diseases still seems to be a fairly common one. It has, however, been established that applications of lime tend rather to increase than to decrease attacks of root disease.

It is therefore again stressed that the majority of root fungi of tea—*Rosellinia*, *Fomes*, *Poria* and *Armillaria*—prefer alkaline conditions for their growth, which the application of lime would tend to bring about. Furthermore, while these organisms are able to thrive in fairly acid soils, increased acidity definitely inhibits their growth. It stands to reason, therefore, that any application made to the soil with a view to checking root diseases should aim at increasing its acidity rather than its alkalinity.

Nursery Diseases.—Eelworms have continued to be the only major problem in the nurseries and beyond undertaking precautionary measures at the time of selection of the site, very little in the form of control seems possible when once these worms have started attacking the plants.

Nursery plants have often been received which on examination have shown no indication of any pathogenic attack; the root growth in these plants was not normal, instead, they had developed numerous spindly roots at the collar and a good tap root was invariably absent. It is presumed that these characteristics are produced by some adverse soil conditions, but definite evidence, however, is lacking in support of this suggestion.

GREVILLEA ROBUSTA

Phyllosticta Leaf Disease.—The limits of activity of the disease seem to be extending, the disease having been recorded at an altitude of nearly 4,500 feet. Until comparatively recently it had been confined to the lower elevations.

Its rapid spread has been the cause of some alarm on estates where the problem of shade is keenly felt. From the enquiries received the incidence of the disease has been severe. Apart from spraying there is no other known method of dealing with this disease. The Australian authorities who were addressed in the matter have given the information that the disease there occurred in forest nurseries and was brought under control by the application of Bordeaux mixture (3: 4: 40) applied twice at intervals of a fortnight. Similar applications made on an estate to fairly old trees have cost the estate from Rs. 8 to 10 for every hundred trees treated. Because of the experiment having been undertaken only recently and because of the very dry conditions that have since prevailed, the effects of the fungicidal application have not yet been indicative.

It is proposed to investigate further the several aspects of the disease, report having been received of the serious nature of it from the Anamallai District.

Branch Canker.—Grevilleas seem to suffer badly from a canker disease in some of the districts, the specimens so far collected having shown the presence of two common organisms on the diseased bark over

the cankers, viz., a species of *Hypoxyton* and what appears to be a species of *Ustulina*. Further collections are being made to study the subject as opportunities arise.

ALBIZZIA MOLUCCANA

Die-back and Branch Canker.—On some of the estates in the Peermade District, a die-back and canker disease of *Albizzia moluccana* has made its appearance, and with a view to ascertaining the cause, a visit was made during the middle of February 1939 to the district. The following observations on the disease are based on the data available on the subject.

The trouble seems to have started sometime during May 1938; at least it was then that a large number of the trees showed the damage to an extent to attract notice.

The topmost branches of the trees were found bereft of their foliage. These empty shoots standing out prominently. Several such shoots examined revealed that a good number of them were still green, but the tips of these shoots were dying back in many cases. The die-back seemed to be extending downwards sometimes involving the entire shoot. Such of the shoots that still remained green in spite of their having shed their foliage were attempting to throw out fresh leaf buds in a normal manner. Enquiries as to whether there had been defoliation to any considerable degree preceding the die-back elicited the information that no such abnormal occurrence was noticeable at any time either before or after the rains.

No fungal growth of any type was apparent on these die-back shoots. but a Membracid bug and its egg masses were constantly seen on them. Attempts at isolation of any fungus from the defoliated shoots have not met with success.

The dead parts of the shoots had shrunk in size and shrivelled irregularly. No canker in this region was apparent.

The canker was confined to the branches carrying the leafy shoots. The cankered branches were partly dead and the cankers themselves were situated either at the region of the axil or midway between any two nodes. Some of the cankers were about six inches long and nearly two inches broad. The damaged area was of a reddish colour and depressed from the general surface of the branch. The dead bark on the canker was still intact but exhibited a few irregular longitudinal splits. The part of the wood which was in immediate contact with the canker was also dead. but in no case had the damage extended over the entire circumference of the affected branch. Cankers were not confined to any particular surface these being found distributed at intervals on any of the surfaces. Between the cankers the branch appeared green and healthy and bore here and there green shoots which in no way appeared to be diseased.

During the present visit no organism was evident on any of the damaged branches and isolations from specimens brought from the estate have not thrown any light on the organism concerned. Only the vegetative mycelium of the fungus from the diseased area has so far been obtained.

In the absence of precise knowledge of the cause of die-back it has been thought that as a possible preventive measure the cutting back of all diseased shoots would be advantageous. Attempts are, however, to continue to elucidate the cause of the disease.

Death of Branches.—Another common disease that has often been noticed on the branches of *A. moluccana* results in the death of the affected branches with no indication of any canker as in the case already described. Diseased branches have consistently shown the growth of a *Stilbum* and an ascomycete associated with it. Comparison with similar growths found on tea shoots suggest the organism being synonymous with *S. cinnabarinum* and its perithecial form *Megalonectria pseudotrichia*; these organisms have been described elsewhere in this report. Isolations have been made and the fungal growths seemed to be identical.

The wood of the branches was sometimes found discoloured but more often streaked with black lines.

Canker on Main Trunk.—A few trees with some abnormal feature in the bark of the stem attracted attention and closer examination in at least one instance showed a fungal growth. The wood beneath the bark was dead and on the extremities of the damaged bark a long canker was evident. The fungus was found spreading to the neighbouring healthy tissue. From the fructifications it has been made out to be a species of *Fomes*. The colour of the mycelium was also characteristic of the same organism. Specific identification is being attempted.

A species of *Diplodia* has also been obtained from die-back branches with discoloured wood. But the time it has taken to produce its fructification on the attacked branches casts a doubt as to the real significance of its presence. It is possible that the *Diplodia* has been of secondary importance. Isolations from the wood have produced the characteristic spores of the organism on agar slants.

CROTALARIA ANAGYROIDES

In addition to the leaf disease caused by *Parodiella grammodes* described in an earlier report of this department the plants seem to suffer from a species of *Nectria*. Attacked plants have been observed to wilt and die. The fungus is found attacking the plants at their base and a species of *Fusarium*, presumably representing an earlier spore form of the *Nectria*, has also been found on the affected parts.

Cultures from the ascospores and conidia have produced only the conidia but there appears to be a microconidial form also. Because of this difference in the life-history of the two species of *Nectria* it is not considered to be of much importance from point of view of the tea disease discussed already.

RUBBER

Rubber mildew (*Oidium heveæ*).—Its occurrence on South Indian plantations was recorded in the report for 1936-37. Available evidence

suggests that the disease is extending to areas that were previously considered free from it. Dusting as against spraying seems to be the more effective way of dealing with this disease, and in view of the spreading activities exhibited by the disease it is highly desirable that trials in this direction should be started.

Phytophthora Disease.—An opportunity afforded itself for observing this disease at first hand over the entire period of its activity. The following data collected at the time are given, not because of any new feature that has come to be noticed but because of the enquiries received as to the identification of the disease. Most of the observations included here are already on record in the recognised books dealing with rubber diseases.

The disease is prevalent during the rainy months of the year and appears in a rather severe form when fruit formation on the trees is heavy. The disease starts with the fruit and thence it is transmitted to the other parts of the tree, notably the leaf bearing shoots and the leaf stalks. The attack on the foliage is made out by the presence of a black patch on the petiole. The leaf-fall is caused by the water passages getting blocked up as a result of fungal growth. The fungus, except on the very tender leaf buds and the youngest leaves, has not been seen on the leaf blade. The attack on the bud encourages the fungus to grow on the shoot also; in the latter case the entire shoot might die.

Water or dew drops are necessary for the transmission of the spores of the *Phytophthora*.

Spraying against *Phytophthora* attacks is usually done in the dry weather just preceding the rains, and this might with advantage be postponed till as late a date as possible before the commencement of the rains depending upon the extent of area to be sprayed and water facilities available on the estate. As the application is done more as a preventive to protect the plant during the rainy months (when the disease is active) the addition of an adhesive is of additional advantage.

Die-back of Seedlings.—*Rhizoctonia bataticola* was found on specimens of seedlings received from an estate and reported as dying. It was suggested that the fungus attacked the plants when the latter were weakened as a result of some physiological condition, or drought; this suggestion found confirmation in a subsequent letter received from the same source. The more vigorous plants in the same nursery did not seem to have been affected by the fungus.

Rhizoctonia bataticola also attacks tea plants when they are in the nursery almost under the same conditions as explained above. Recovery has not infrequently been observed with better climatic conditions and when the fungus had not invaded the main roots of the plants.

The size of the sclerotia obtained out of cultures from the rubber specimens are smaller than those that have been obtained from the tea plants. The material has been kept in culture for later comparison.

Rubber Seeds.—A few samples of *Hevea* seeds which were reported to have failed to germinate were found attacked by species of *Colletotrichum* and *Fusarium*. On the available evidence the suggestion was made that the seeds were perhaps not quite mature. The cotyledons were covered by these two moulds in the form of a slightly pinkish growth.

Red Root Rot.—This fungus was found attacking specimens of young rubber plants.

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M. K. SUBBA RAO,
Mycologist.

SUMMARY OF THE REPORT OF THE MYCOLOGIST

The Mycologist has spent the year under review in South Travancore. The main work has been investigation into a serious and widespread fungal disease of Tea which causes a canker and die-back of the branches. Advisory work on other diseases of Tea, shade trees and green manures has continued, and advice has been given on a number of Rubber enquiries.

TEA

Leaf Diseases.—Black Blight disease has been prominent during the year. In the ordinary way it is not necessary to spray against this disease which makes its appearance chiefly during the wet weather and usually passes off with the advent of dry weather. It may, however, become serious, in which case spraying the affected bushes with Bordeaux mixture is recommended. There is a marked similarity in the external appearance of Black Blight and 'Souty Mould', and one is often mistaken for the other. 'Souty Mould' is associated with the honey-dew exudations of insects, and control amounts to control of the insects.

Stem Disease.—*Die-back and Canker* (referred to as Die-back). As pointed out above a detailed investigation is proceeding into a disease of Tea branches which is widespread and serious in parts of Travancore. The disease is due to a fungal infection which causes the formation of cankers on wood up to pencil thickness and occurs usually in the first year after pruning. For some time it has been generally considered that the Pink Disease fungus was the causal organism, but this has been disproved.

Symptoms of the Disease.—The disease is first noticed by the drying up of young shoots and consequent yellowing of the leaves. The shoots eventually die and are easily detached from the main stem.

The infected branches show numerous gnarled cankers along their length, and the bark becomes a dirty brown colour.

The symptoms are most conspicuous during the dry weather although careful search shows shoots in various stages of cankering during the monsoon.

The fungus apparently gains entrance through a wound such as a leaf scar or a wound caused by tipping or some injury to the bush.

The Causal Organism.—While a number of fungi have been isolated from cankered areas it seems fairly conclusively established that the causal organism is the fungus *Nectria subquaternata* Berk. & Br. The fungus forms small pale-pink cushions on the bark, and is probably most active shortly after the beginning of the rains.

Incidence of the Disease.—The disease seems to be at its worst during the first year of the pruning cycle, the intensity of attack diminishing the further the bushes are from pruning.

Relation between Helopeltis and Die-back.—While *Helopeltis* and 'Die-back' are commonly found together, there is no evidence of any association between them. It is not considered, for example, that *Helopeltis* is an agent in the spread of the 'Die-back' from one bush to another.

Pruning and 'Die-back'.—Dry weather pruning is common in an effort to combat *Helopeltis*. In one area pruning during late February and March was followed by freedom of attack from 'Die-back', but as this is an isolated case more evidence is required before it can be confidently suggested that later pruning leads to freedom from 'Die-back'. Heavy pruning appears to encourage the disease, and make its effects more serious than lighter pruning.

Vitality and 'Die-back'.—Lack of vitality in the tea bushes appears to make them highly susceptible to attack. Experiments in resting, manuring and cultivation have been planned with a view to ascertaining to what extent 'Die-back' is a debility disease, and how best to prevent it.

Control Measures.—Control by spraying with Bordeaux mixture gave inconclusive results in a preliminary experiment.

Direct control by cutting out all infected branches is being attempted. It is a laborious process, but the initial results are promising.

Improvement of the vitality and health of the bushes by cultural methods and manuring, and judicious pruning appears to be the one hopeful method of dealing with the disease. Investigations continue.

Leptothyrium Theae.—This fungus causes a die-back of young shoots developing after pruning. Foliage of infected shoots becomes yellow and gradually turns brown and dies. A ringed appearance (but no canker formation) may be noticed at the base of attacked shoots, and the surface of the bark a little above the base shows numerous pin-head outgrowths. The disease becomes apparent during dry weather. In Ceylon death of bushes as a result of the fungus ringing the collar has been reported, but no such serious results have yet been reported in South India. Cutting off the infected shoots should be adequate control. The disease has been reported from the High Ranges, Vandiperiyar and South Travancore.

Root Diseases.—There is nothing new to report. It has been established that liming encourages root diseases, and is no preventative.

Nurseries.—A number of nursery plants have been sent for examination on which no pathogenic agency has been found. Root development was often abnormal and the failure is probably accounted for by adverse soil conditions.

GREVILLEA ROBUSTA

The *Phyllosticta* leaf disease of grevilleas is spreading rapidly to higher elevations and becoming more serious. Investigation into the several aspects of the disease is planned for the coming year.

ALBIZZIA MOLUCCANA

A die-back and canker disease of Albizzias has made its appearance in the Peermade district. A short visit was paid to the district in the middle of February to investigate.

The disease is characterised by a defoliation of the higher branches and usually die-back of the shoots. Attempts to isolate a fungus from these shoots have failed. There was no cankering on these shoots.

Larger branches, however, showed cankering, the damaged area being reddish in colour and depressed from the general surface of the branch. Cankers were distributed at intervals, and the branches appeared green and healthy between the cankered areas. In no cases were the branches completely ringed. Investigation is to be renewed with the advent of the monsoon. Meanwhile a possible preventive measure would be cutting back of all diseased shoots.

RUBBER

Observations have been made and advices given on the following diseases of Rubber:—*Oidium heveae*, *Phytophthora*, *Rhizoctonia bataticola* (disease of seedlings), *Colletotrichum* and *Fusarium* (disease of Rubber seeds), and Red Root Rot Disease.

REPORT OF THE SOIL CHEMIST

Work during the year was purely advisory consisting of routine analysis of and reporting on 61 samples of compost, 10 samples of cattle manure and 218 samples of soil. These figures represent a decrease in the number of compost samples, and a considerable increase in the number of soil samples. Practically no time was left for research work.

Composts.—The physical texture and chemical composition of majority of compost samples were very satisfactory. The chemical composition is bound to vary very widely according to the nature of raw materials used for composting. In a very great majority of cases it is clear that the green material used for composting was collected from outside the tea area. This amounts mostly to jungle material, but in a number of cases green material is specially grown on waste land or swamps for converting into compost. Sunflower and Mugwort are two non-leguminous plants which have been grown with success for composting. In one case a sample was received of compost made with the discarded leaf in picking over. This compost showed an excellent analysis (wet basis) as follows:—

Moisture.	Loss on Ignition.	Nitrogen.	Phosphate.	Potash.
%	%	%	%	%
47.8	23.7	.92	.305	.58

It was not unusual to receive samples of highly earthy compost. The main sources of soil adulteration are (1) the addition of large quantities of urine earth, (2) soil distributed by white ants in the heap, (3) large amount of earth adhering to the green material, and (4) earth from the bottom, sides and surrounding parts of the pit getting indiscriminately mixed with the decomposing material. While the organic matter loses weight during composting, soil does not, so that in the final sample earth predominates to a great extent. The question has been raised about the necessity or otherwise of allowing the green material to wilt before adding it to the heap. It cannot be claimed that it is absolutely necessary to allow the material to wilt in making a good compost, but especially with the more leafy material, a much better physical condition is attained in the heap if the material is first allowed to wilt and become springy. The improved physical condition allows better aeration and therefore more complete and quicker decomposition. A summary of the analytical figures of composts on wet basis is appended.

Soils.—Soil samples were received from tea area, swamps, nursery sites and grassland.

In a number of cases the soil samples were sent in for some special reason; such samples being sent from poor areas or in connection with working out manurial and cultivation programmes. On the other hand many samples were received for analysis and no object was given for the analysis. When the figures for the analysis of such samples show

the soils to be in the nature of the average for the district, further enquiries reveal that it is first intended to make sure there is nothing intrinsically wrong with the soil before adopting special measures in the case of disappointing areas.

The object of obtaining analysis of swamp soils was to determine their value as a top dressing for tea.

Mechanical analysis of soils was also carried out, the method followed being Robinson's pipette method after preliminary treatment with hydrogen peroxide.

The average figures of the soil analyses are appended, arranged according to district. These figures cannot in any way be taken to be representative of each district, since in a large number of cases the samples are sent from special areas. No general conclusions can be drawn from these figures. It is, however, noticeable that the soils on the whole are well supplied with nitrogen and potash though the actual percentage varies. Total phosphate though not high, is present in sufficient amounts. It is not uncommon to find that the available phosphate is extremely low, especially in the heavier type of soils. The low availability of the phosphate is due to high iron and aluminium content and low percentage of calcium in these soils.

Acidity.—The pH value of 201 soils was determined by Quinhydrone method. The sub soils were more acid than top soils. The pH values are given below:—

Samples	pH Value
51	Between 4.5 and 5.0
116	5.0 and 5.5
17	5.5 and 6.0
17	6.0 and 6.5

Dr. H. H. Mann in 'Tea soils' (Technical communication No. 32, Imperial Bureau of Soil Science) says that 'the ideal pH value for a tea soil probably lies somewhere between 5.2 and 5.6 though many successful tea soils have a much lower value than this'.

It is seen from the figures given above that majority of the samples show a pH value between 5.0 and 5.5.

It appears that the pH value of soils can be appreciably altered either towards acidity or alkalinity if extremely heavy applications of acid or alkaline manures are made. This is of greatest importance in nurseries since the growth, health and vigour of young tea plants are largely determined by the soil reaction. No cases have come to notice so far, where failure of nursery plants has been due to high acidity, but the pH of soils in some nurseries which have failed has been found to be high for tea (i.e. about pH 7).

The addition of cattle manure or compost to nursery soils is advocated especially in view of the fact that the physical condition of the soil is improved, but excessive applications may so alter the soil reaction as to be harmful to the young plants.

SUMMARY OF COMPOST ANALYSES

Estate	No. of Samples	Moisture %	Loss on Ignition %	Nitrogen %	C/N ratio	Phos- phate %	Potash %
KANNAN DEVANS							
1	1	28.3	8.6	.29	11.0	.16	.77
2	5	51.0	18.5	.62	12.3	.28	.86
3	2	55.4	20.1	.87	10.0	.44	1.03
4	1	67.4	16.3	.48	14.3	.18	.71
5	2	33.1	18.0	.64	12.6	.34	.72
6	2	58.4	10.5	.35	13.2	.23	.36
7	2	44.9	16.3	.52	12.6	.14	.52
CENTRAL TRAVANCORE							
1	3	63.3	17.6	.46	17.4	.17	.53
2	1	30.5	14.6	.46	14.3	.27	.76
3	4	64.6	16.7	.52	12.9	.19	.65
4	3	66.1	16.5	.44	17.7	.16	.36
SOUTH TRAVANCORE							
1	2	41.0	19.0	.76	12.2	.38	1.65
WYNAADS, NILGIRIS AND MALABAR							
1	3	33.3	14.8	.51	...	.46	1.02
2	1	61.5	11.1	.41	12.7	.16	.26
3	2	23.0	30.0	1.17	9.8	.51	1.34
4	2	31.5	17.3	.53	12.8	.29	.87
5	1	43.7	26.2	.88	12.0	.36	.55
6	1	25.3	15.8	.41	...	.38	.94
7	1	32.4	29.6	1.26	10.6	.58	1.33
8	4	39.7	19.0	.74	13.8	.43	1.10
9	4	52.8	18.9	.70	12.1	.29	.80
10	1	29.3	18.8	.79	10.0	.40	.38
11	1	62.2	11.1	.38	14.0	.28	.33
12	8	54.0	20.0	.58	...	.22	.50
13	1	48.9	17.7	.45	12.7	.15	.26
ANAMALLAIS AND OTHER DISTRICTS							
1	1	58.9	12.0	.35	14.3	.22	.27
2	1	22.8	32.1	1.02	...	.40	.45
3	1	24.9	20.6	.78	...	.30	1.90
61							
Average ...							
		44.6	18.1	.62	12.8	.30	.76

SUMMARY OF SOIL ANALYSES

KANNAN DEVANS

Estate	No. of samples	Nitrogen %
1	2	·23
2	6 Grassland	·47
3	4 Grassland	·38
4	6	·30
5	2	·25
6	5 Grassland	·24
7	6	·32
8	2	·15
9	1	·28
10	6	·52
11	4 Grassland	·27
12	1	·42
13	4	·33
14	2	·29
15	3	·38
16	2 Grassland	·66
17	2 Grassland	·47
18	6	·65
19	6	·26
20	4	·33
21	6	·15

Estate	No. of Samples	Loss on Ignition %	Nitrogen %	Phosphoric Acid		Potash	
				Total %	Avail-able %	Total %	Avail-able %
NILGIRI WYNAAD							
1	36	24·6	·48	·10		·53	
2	6	21·6	·44	·08		·56	
3	20	13·3	·28	·14		·44	
4	6	23·1	·52	·12		·57	
5	1	26·4	·53	·08		·58	
6	3	24·0	·64	·15		·78	
7	1	12·4	·18	·09	·0025	·28	·018
8	2	11·5	·10	·145	·0031	·13	·01
9	1	12·8	·18	·11	·0035	·165	·02
10	3	25·0	·60	·10		·50	
11	5		·18	·08		·48	
ANAMALLAIS							
1	1	12·8	·235	·12		·41	
2	1	14·6	·18	·04	·0033	·24	·034
3	1	14·7	·225	·105	·0048	·30	·014
4	1	14·7	·20	·12	·0035	·31	·017
5	6	6·7	·094	·04		·71	
SOUTH TRAVANCORE							
1	22	9·5	·12	·08	·0028	·26	·022
2	2		·185	·105		·30	

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Soil Chemist.

UNITED PLANTERS' ASSOCIATION OF
SOUTHERN INDIA

TEA SCIENTIFIC
DEPARTMENT

ANNUAL
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